# SAE JOURNAL

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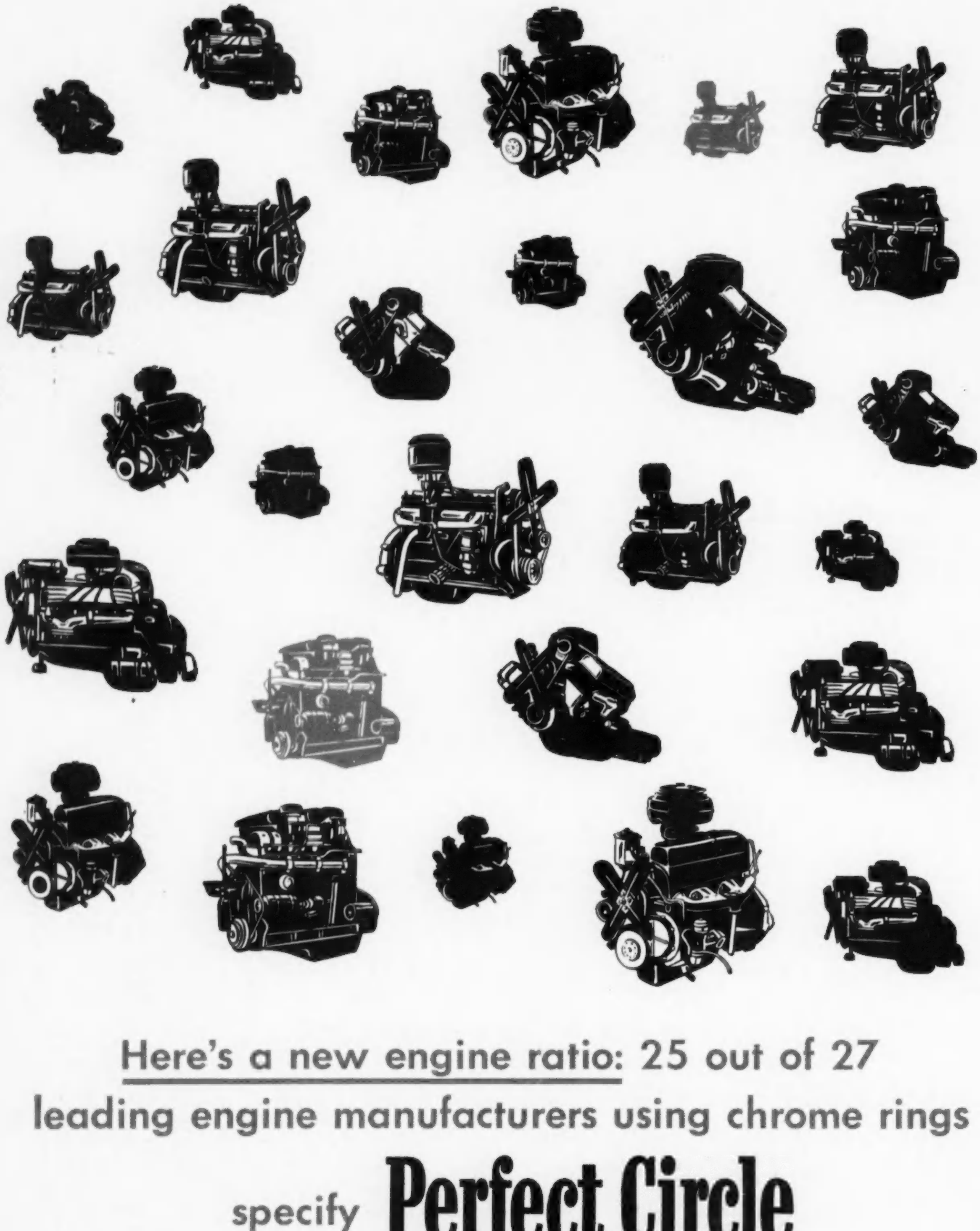



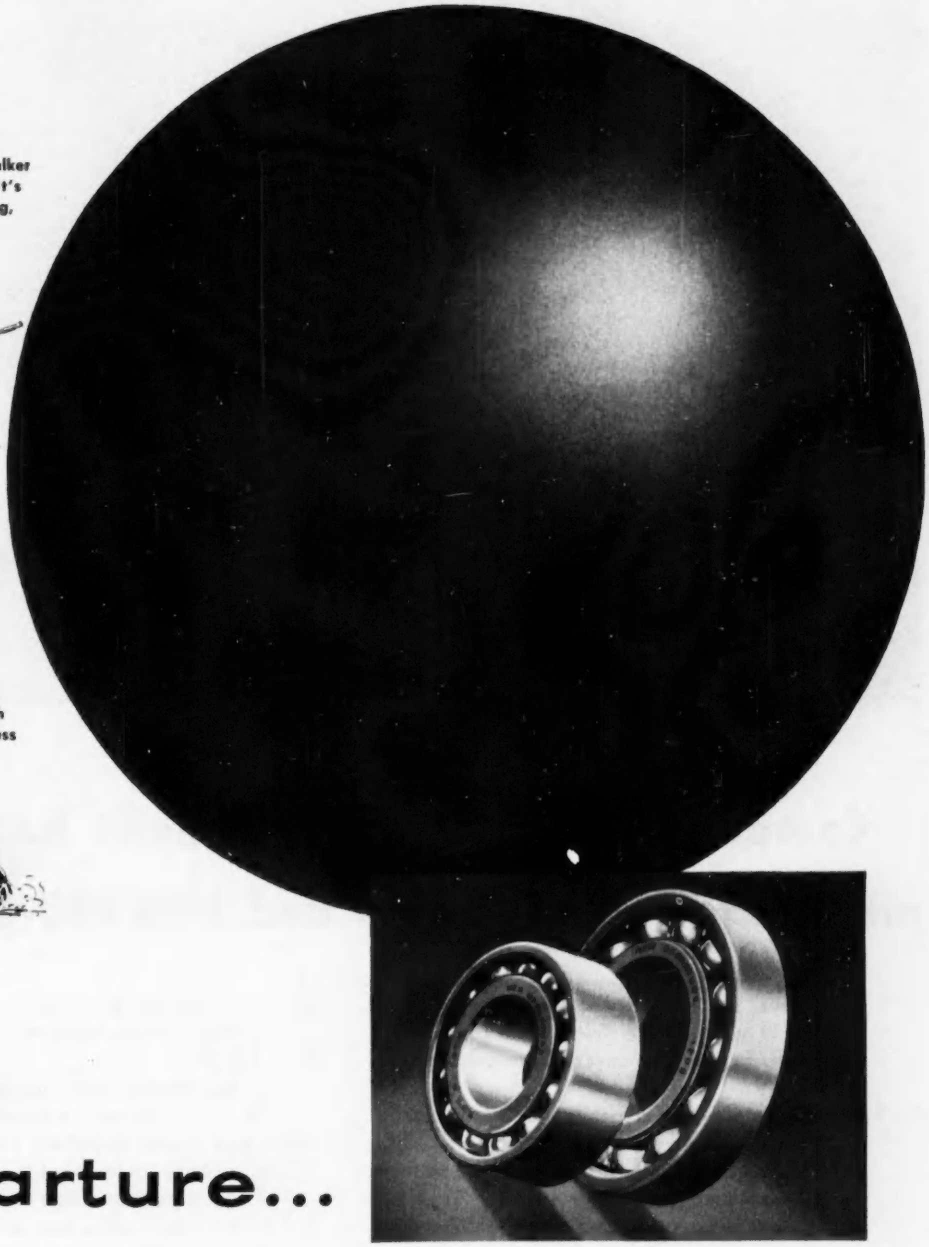

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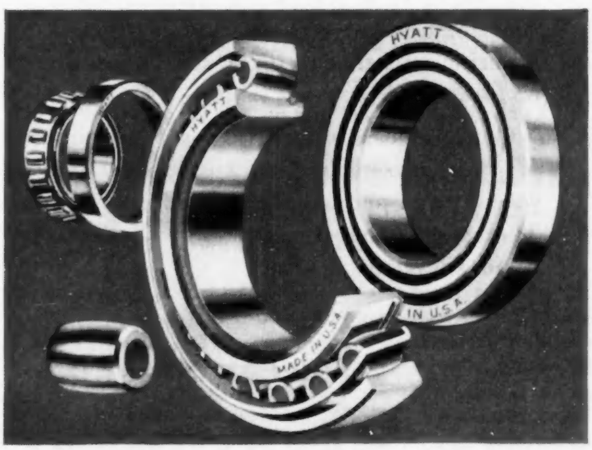


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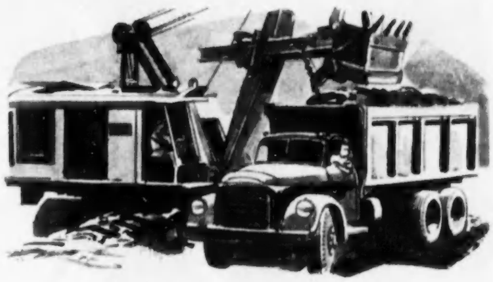

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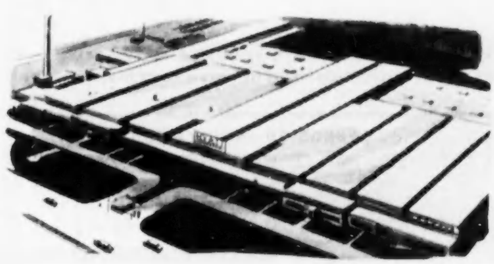

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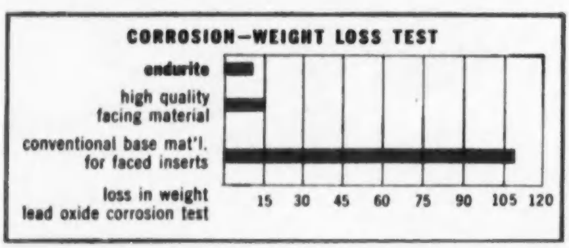


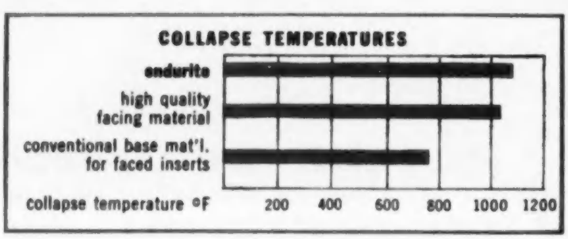


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# For the Sake of Argument

## On the Inside Looking Out . . .

By Norman G. Shidle

Most folks have some sort of personal philosophy of life . . . some better formulated than others. . . . But almost all of us have done some very private thinking on "what it's all about."

And, if we could see way down inside each other, chances are we'd find that that very private thinking made a lot of sense to each other. We'd likely find, at least, that it wasn't so different from our own as human actions and reactions had been indicating.

We'd probably find, too, that all of us are pretty much like the farmer to whom the County Agent was trying to sell new methods for farming more efficiently. The County Agent was getting nowhere. Finally, he said in some exasperation:

"Do you mean to stand there and tell me that you don't *want* to learn to farm better?"

"That's exactly what I'm standing here and telling you, mister," the farmer replied, adding: "Shucks, I ain't farmin' half as well now as I know how."

We're most of us like the farmer for several reasons. One is because of our attitude toward that personal philosophy we've developed in our very private thinking. We keep regarding it as something *outside* our daily life. We keep living and acting within a physical framework, occasionally peeking out to view briefly our private philosophy. Then we turn back and go about our business within the physical framework of the daily grind.

We'd get different results probably, if we reversed the whole relationship . . . if we made that personal philosophy of ours the framework within which we live and act.

Then our everyday, "practical" thinking would be referenced to it; not it to our everyday thinking.

Our private philosophy too often gets treated like a visitor or a friend in our home. We enjoy having him; we like to feel he'll stay nearby in time of trouble. We welcome his visits and thoroughly approve of him . . . but we never seriously consider giving up our present home and going to live with him.

Pertinently, Aldous Huxley once said: "Theory is not practice—and words are not the things for which they stand."


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# Curb that Jet Appetite for Fuel

**J. G. Borger,** Pan American World Airlines

Excerpts from paper "Meeting the Jet Transport Challenge" presented at a meeting of the Metropolitan Section of the SAE, New York City, March 5, 1953.

THERE has been much talk that the jet transport is too uneconomical to permit operations at fares competitive with those offered with current piston-engined aircraft—for current fares are the lowest in history. These low fares have been achieved primarily through engineering development. True, full credit must be given to all of the people in the many varied jobs with the airlines and aircraft manufacturers for increased efficiency. But primarily these low fares can be attributed to the greater productivity of the airplane in terms of ton-miles per year and through increased payload, speed, and range performance of the airplane.

Why should not the jet exhibit the same characteristics? I am reminded of a study made slightly before my time. This very impressive document—written in 1939 or 1940—proved conclusively that any transport airplane that flew faster than 190 to 200 mph would be uneconomical. And, I can remember many competent people in the industry seriously questioning 10 years ago whether a 300-mph airplane such as the Constellation could be operated at fares competitive with the 200-mph transport.

It seems to me that this is the real challenge. There is no question that the jet transport has an appeal to the traveler through high speed and comfort. Four or five years from now, he is not going to be content until we airplane operators can offer him competitive jet service. To meet this demand with economic equipment should be the next objective of air transport engineering.

One must agree that the operating economy of the first jet transport is not wholly satisfactory. The fuel consumption of the engine is high, the capacity of the airplane is relatively small, the range is limited. But that is why de Havilland has undertaken Comet II to follow after the original Comet I and Comet III to follow after Comet II.

Just how good is the Comet III? Well, it will carry 60 passengers, with baggage and mail, 2700 miles, with moderate reserve fuel remaining, at an average cruising speed of just under 500 mph. It will be powered by four Rolls-Royce Avon RA-16 engines rated at 9000 lb thrust each for take-off. It will have a fuel capacity of about 9700 U.S. gal. It will gross approximately 145,000 lb for take-off and 100,000 lb for landing. It will cruise at altitudes ranging from 37,000 to 45,000 ft with a cabin altitude not exceeding 8000 ft. In appearance, the major difference from the present Comet will be the additional fuselage length and the external fuel tanks projecting forward from the wing leading edge. It will be operated by a basic crew of three, plus two cabin attendants. Its interior can readily be converted from 60 passengers for first-class travel to 78 passengers in the tourist configuration. For take-off on flights of extreme range, it will operate on runways about 7500 ft long in hot weather; for landing under similar conditions, the runway

**Table 1—Typical San Francisco-Honolulu Operation (2115 Nautical Miles)**

| | DC-6B | DC-7 | Comet III | |
|---|---|---|---|---|
| Maximum Take-off Weight, lb | 107,000 | 122,000 | 145,000 | |
| Passengers | 56 | 60 | 60 | |
| Payload, lb | 14,300 | 16,500 | 15,300 | |
| Block Time, hr:min | | | | |
| Westbound | 9:15 | 8:00 | 6:00 | |
| Eastbound | 8:27 | 7:12 | 5:15 | |
| Round Trip[a] | 21:42 | 19:12 | 15:15 | |
| Fuel Grade | 108/135 | 115/145 | Kerosene | Light diesel |
| Fuel Consumed (Round Trip), lb | 42,140 | 44,376 | 98,600 | |
| Fuel Consumed (Round Trip), gal | 7,140 | 7,520 | 14,730 | 14,230 |
| Fuel Cost, $ | 0.205 | 0.205 | 0.135 | 0.125 |
| Fuel Density, lb/gal | 5.9 | 5.9 | 6.7 | 7.0 |
| Fuel Consumption, lb/mile | 8.65 | 9.09 | 20.2 | |
| Fuel Consumption, gal/mile | 1.47 | 1.54 | 3.02 | 2.92 |
| Fuel Cost, $/mile | 0.300 | 0.316 | 0.408 | 0.365 |
| Relative Speed, % | 100 | 107 | 145 | 145 |
| Relative Fuel Cost, % | 100 | 105 | 136 | 122 |

[a] Includes 4-hr layover.

required is less than 7000 ft. And let no one underestimate the basic overall quality of the airplane.

As an example of the uneconomic characteristics of the jet transport, extreme differences in fuel consumptions of the jet- and piston-engine transport have been cited in terms of pounds of fuel consumed per mile flown. Well, let's take a look at Table 1, which gives the figures for two piston-engine airplanes and the Comet III. In this particular aspect the DC-6B probably is the best of those now flying. Neither the DC-7 nor the Comet III is flying yet, but their aerodynamic characteristics have been sufficiently well established to make a fair comparison. Just to play safe we'll use the customary 5% margin on fuel consumption for the compound engine, and 8% for the jet. The speeds for the jet not only include allowance for the higher winds at altitude, but a small cushion under anticipated values.

The fuel costs assumed in Table 1 are representative averages, used for purpose of obtaining a more uniformly applicable comparison. Specific costs for various points in the world will vary somewhat from those shown, but the conclusion will still apply. Analyses made for other routes will vary slightly, especially with regard to relative fuel costs, and where the currently greater range of the piston-engine plane enables it to skip over fueling stops that the jet has to make.

Note that pounds per mile is only one criterion. No one buys fuel by the pound. It is bought by the gallon. And you get more pounds—or Btu—for the gallon in jet fuel than you do in gasoline. It is probable that commercial turbine fuel will be no lighter than kerosene, and there are many attractive aspects to the use of diesel fuel, or the No. 2 heating oil that many of us use for heating our homes. These fuels are much cheaper than the high-octane aviation gasoline required for reciprocating engines. So, while in most cases we end up with a higher fuel cost per mile for the jet, the increase in relation to that for the DC-6B is less than the increase in speed. Improvements in fuel consumption of the jet engine and incorporation of advanced aerodynamic features would serve to reduce the difference further. It always requires more energy to move a larger body faster; only improved thermodynamic efficiency would permit reduced fuel consumption in such a case. The history of transportation has shown that it is always desirable to use more fuel to obtain high operating speeds.

Note the difference in fuel cost per mile for the two types of turbine fuel. Another way of presenting such differences is shown in somewhat more detail in Table 2.

This shows the gains in fuel cost that can be achieved by using fuel with greater Btu per gallon content. If diesel fuel were used instead of kerosene, the annual savings on the basis of two round trips per day on this route alone would amount to $150,000. Of course other problems are introduced: heating would probably have to be applied to the airplane fuel system to assure steady flow of the heavier fuel from tank to engine, but it now appears improbable that enough kerosene can be provided with a freezing point low enough to avoid such heating. Such heat should not be too costly, for there is waste heat generated in an airplane from such equipment as the intercoolers and other heat exchangers. Another problem may revolve around developing turbine-engine combustion chambers to be more tolerant of the heavier fuel.

This is one example of the means of meeting the challenge of jet transports. Through such application of aeronautical engineering abilities and a combined attack on the problem by the entire industry there is every reason to believe the economy of the jet transport can be superior to that currently experienced.

Here are some other suggestions as to ways and means of improving the economy of the jet:

1. The airplane should be designed to be as fast as possible, up to drag rise limits of compressibility.

Such features as swept wings, thin airfoil sections, and high cruising altitudes all contribute to operating economy. Studies can be made to show lower unit costs for other configurations, but we must also consider the revenue attracting abilities of higher speeds, for costs alone do not provide the whole picture of economy.

There is one other aspect of speed to consider. Faster airplanes can achieve greater utilization. Note in Table 1 the differences in round trip time, with allowance for 4-hr layover at the western end of the flight.

It is too complex a subject to get into detail in this paper, but the decrease in time required to get back to the main terminal should permit the jet transport to be turned around again to go out on another schedule. These time differences can become days rather than hours on long haul operations. On short haul, where frequent schedules are offered, greater advantage can be taken of the smaller time increments. What we are really interested in is not hours per day but miles flown and payload carried per day.

2. Another way to improve the economy of the jet transport is to increase its carrying capacity. The easiest way to achieve low operating costs per seat mile still seems to be by combining as large a number of seats in as small a vehicle as possible. With the high initial costs predicted for a jet transport, it is necessary that it carry more passengers to compensate.

3. The jet transport should be flexible. Pan American developed for its "Strato" Clippers a method permitting quick conversion of the cabin interiors from Sleeperette to standard layout. This basic idea was carried further by Douglas in our DC-6B's, so that we are now operating these same aircraft in three basically different interior arrangements: as a 56-passenger first-class arrangement to South America, as a 44-passenger sleeperette airplane for the long haul to South Africa, and as an 80-passenger tourist configuration in the transatlantic Rainbow service. This convertible cabin has been adopted by other operators, primarily in the international field. While further refinements are needed, it has been quite successful in improving operating flexibility.

4. If the advanced jet transport is going to cost so much—we've heard prices mentioned anywhere from 2½ to 4½ million dollars—we'd better know how to operate it when it finally comes. Not getting full utilization out of such an airplane will be extremely costly. The jet introduces many new operating problems. The only satisfactory way an airline can solve problems of this type is to put an airplane in actual operation. What better way to accomplish this than with a suitable cheaper airplane? Through experience gained with the Comets, air carriers will be ready for early efficient operation of the larger and improved advanced jet transport, when it arrives on the scene.

5. Indications are that turbine-engine maintenance may be rather costly, due primarily to low overhaul periods and high parts replacement rates at overhaul. Increasing the overhaul period from 500 to 1000 hr may have the effect of decreasing costs per seat-mile 10-15% and further decreases can be obtained by reducing the number of parts replaced each overhaul. Solution of this problem rests fundamentally with the engine designer, but development of engine reliability is not yet an exact science. New parts must be tried in field service. Experience shows that about 75% of service troubles with a new airplane are located in the powerplant. The airline operator has always made major contributions by developing operating and maintenance techniques that reflect the best compromise between his own requirements and those for best engine reliability. A trend toward more service activity between overhauls for the purpose of extending overhaul periods has already started. We can accomplish only so much in this direction through symposiums and committee action. Actual operating experience is absolutely necessary if we are to make the jet transport efficient.

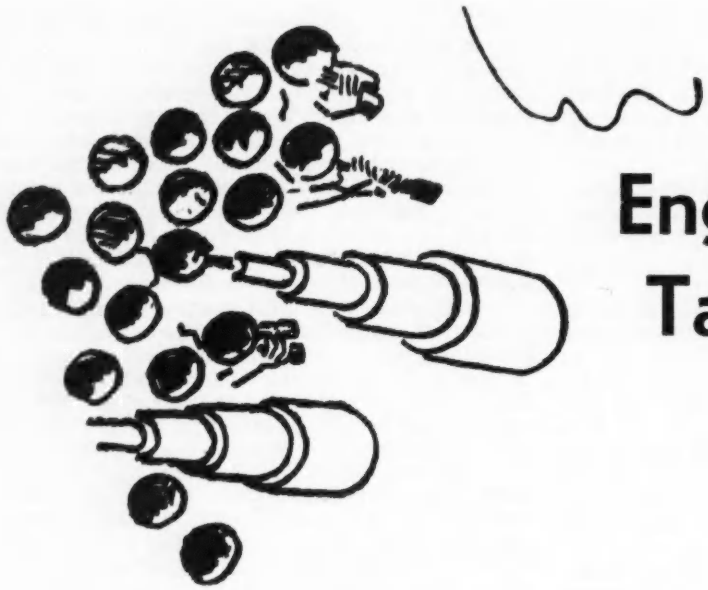
6. For better economy, the jet transport should have more range. Every time an airplane stops, it costs money. Of course, some passengers don't want to go as far as others, but for maximum efficiency, the airplane should be designed to operate nonstop between the key traffic generating points on the route under consideration. Reserve requirements of a jet may limit its range under operating conditions. If reserve requirements can be reduced, proof under actual operating conditions must be obtained.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

**Table 2—Comparative Costs for Comet III—San Francisco-Honolulu Route**

Round trip is 4230 nautical miles—Btu required is $1.831 \times 10^9$

| Fuel Type | 100/130 gasoline | JP-4 | Kerosene | Light diesel |
|---|---|---|---|---|
| Reid Vapor Pressure at 100 F, psi | 6.5 | 3 | Below 0.1 | Below 0.1 |
| Freezing Point, F | Below −76 | Below −76 | −40 | 0 to +15 |
| Weight, lb/gal | 5.9 | 6.4 | 6.7 | 7.0 |
| Heat Content, Btu/lb | 18,900 | 18,550 | 18,575 | 18,400 |
| Heat Content, Btu/gal | 111,000 | 118,720 | 124,452 | 128,500 |
| Cost, $/U.S. gal | 0.19 | 0.145 | 0.135 | 0.125 |
| Fuel Required (Round Trip), gal | 16,500 | 15,427 | 14,730 | 14,230 |
| Fuel Cost, $ | 3,135 | 2,237 | 1,989 | 1,782 |



# Engineers Take a Look at

## Why Dealer Shops?

**C. T. Doman,**
Ford Motor Co.

There are a whole flock of reasons why dealer service shops rate serious consideration by fleet operators. Here are a few:

- Less investment by fleet owners in land, buildings, equipment, and inventories.
- Close relationship of dealer shops with the factory.
- Faster availability of special service tools to dealer shops.
- Factory field schools keep dealer mechanics informed on how to handle routine and special jobs as they come up.
- Fewer shop personnel needed by fleet owner.
- Return of defective parts to the factory by dealers results in faster action.
- Through dealer shops, a factory can better study fleet operation, and make necessary changes in design.
- Often dealer shops can be equipped to do work at lower cost.

## Buy Maintenance!

**F. G. Allen,**
White Motor Co.

Purchasing guaranteed maintenance is the road some fleet owners are taking . . . and for good reason. It can take some or all of the responsibility off their shoulders, depending on the plan they buy. There are three from which to choose. They are:

1. A strictly preventive maintenance contract which establishes a cost per month or per mile for making minor repairs, greasing, and washing a particular truck.
2. A contract wherein responsibility is assumed for repairs and labor for a given truck under given operating conditions at a given cost per mile for either of two periods: 50,000 to 100,000 miles per year or a flat 3-year period.
3. A contract wherein responsibility is assumed for repairs, labor, *and material* under the conditions mentioned for the second plan.

## Self-Service Best

**R. W. Thomas,**
Quality Bakers of America Cooperative, Inc.

We find it better to operate our own service shops than to use dealer shops. Here's why:

Bakeries operating fleets of 50 or more trucks can provide better, less costly service in their own shop than dealers can offer.

Few cities in the 50,000 to 100,000 class where bakers operate 20-to-50-truck fleets have dealers competent to provide the needed service, at any price.

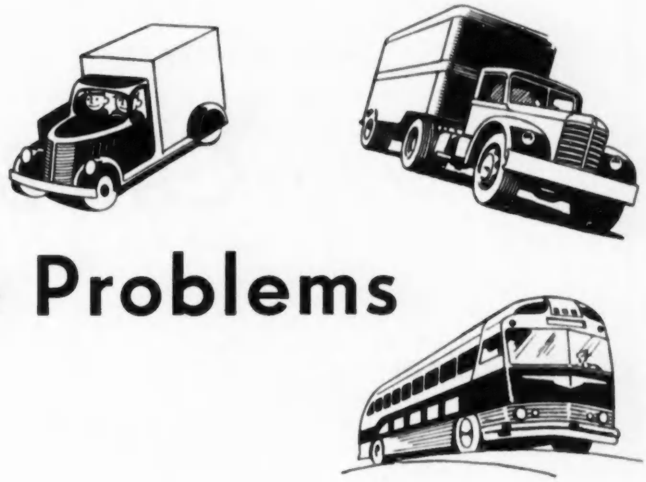
### Mechanic Hits the Road

To service scattered units, we have outfitted a stripped house trailer with a bunk and shower for a traveling mechanic . . . and a work bench with a vise, light grinder, tool racks, and cabinets for spare parts. Among other things carried are a wheel balancer, air compressor, impact tool, and a jack.

The trailer is pulled by a spare

---

This symposium, "An Engineering Approach to Service Problems," was presented at SAE Annual Meeting, Detroit, Jan. 12, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.



# Fleet Service Problems

route truck. When the mechanic arrives at the local distribution point, he detaches the trailer, gives his truck to the salesman, then proceeds to service the local truck.

## Scattered Fleets

**W. H. Langseder,**
Thomas J. Lipton, Inc.

Scattered fleets are practically forced to rely on dealer service shops. But since not all dealer shops are good, operators should make their selections carefully.

Even though he uses dealer shops, the fleet owner still has these three management duties regarding maintenance:

1. Give a fleet superintendent responsibility for economical maintenance of the vehicles—and authority to achieve it. It should be the duty of this superintendent, or his deputy, to cooperate with the dealer shop by giving notice well in advance of work going in, assist in the diagnosis, and, if possible, write the repair orders.
2. Train drivers to operate vehicles properly and to recognize danger signs.
3. Set up a preventive maintenance program tailored to the fleet and an equipment retirement plan—both of which should be re-examined frequently.

## Keep Informed

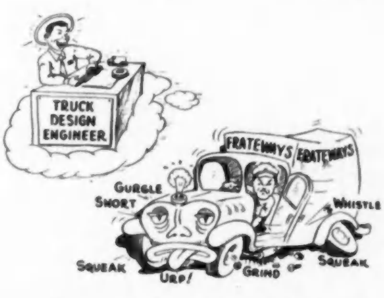
**W. W. Edwards,**
GMC Truck & Coach Division

A well-run dealer shop keeps up with the manuals, parts books, special service letters, and so forth put out by factory organizations. It also sends men to training courses and service conferences sponsored by factory service organizations.

These aids are available also to fleet shops. But fleet shops seldom can spare the men and time to take full advantage of them. This is true especially of shops working on several makes of vehicles.

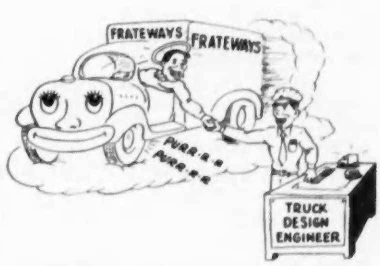
## Who's Got the Halo?

**F. K. Glynn,** American Telephone & Telegraph Co




**1** Who put the halo on the truck design engineer—the guy who fattened the horse and forgot the whiffletree?


**2** Let's open up a communication line between the driver and the truck design engineer, namely, driver trouble reports.




**3** Using driver trouble reports, engineers can get rid of the bugs. But who really rates the halo—the driver!

# Car Brakes Rate

**W. R. Rodger,** Chrysler Corp.

Based on secretary's report of Round Table on Prospects for Better Passenger Car Brakes held at SAE Summer Meeting, Atlantic City, June 9, 1953. Chairman was A. E. Kimberly, Chrysler Corp.

AUTOMOTIVE engineers have not been quite fair with brakes in the past five years. Without materially increasing their size or weight or changing their design or the materials in them, they have asked brakes to handle cars with much higher top speeds and greater accelerating ability. The problems which have been introduced result from the inability of brakes to dispose of heat.

The heat problem in modern brakes can best be illustrated by a simple computation. A 1947 car going 70 mph has 800,000 ft-lb of kinetic energy; a 1953 car going 100 mph has twice this amount. One would conclude that brakes should be twice as big.

When brakes have inadequate thermal capacity, the most common results are:

1. Increased pedal pressure necessary—as brakes become hotter, lining frictional coefficient decreases.
2. Pedal must be depressed farther—necessary because the drums expand thermally and mechanically due to high temperatures and forces imposed during lining fade.
3. Parts such as cups, boots, seals, and linings deteriorate rapidly.
4. Hydraulic fluids boil, causing the lines to fill with vapor. This makes it possible to "floorboard" the pedal without applying the brakes.
5. Parts are subject to greater strain because of the higher pressures. This tends to shorten their lives.

For practical reasons, it becomes necessary to consider the question, "How much punishment will a good, hard, fast driver (but still a sane one) give to a set of brakes, and in what way will this punishment be inflicted?" Although several of today's cars can reach 100 mph, the greatest problem doesn't seem to lie in frequent use of such speeds. Rather the greatest punishment seems to take place on hilly roads where straightaways allow 70 to 80 mph, but turns do not. The newer cars can accelerate between these speeds so rapidly that brake usage is more frequent, and *brakes don't get a chance to recover.*

It has been suggested that passenger-car brakes might be improved if they were made hybrids of racing-car, aircraft, railcar, and existing passenger-car brakes. Actually, however, there are relatively few ideas in aircraft, railroad or racing-car brakes which are directly applicable to present-day automobiles.

In the recent Mexican Pan-American road race, for example, modifications were made in the winning cars to provide additional brake cooling. Scoops were provided which forced air through specially perforated front brake backing plates. Air was forced into the rear brakes by electric motor-driven blowers. While drivers reported more rapid recovery in mountain driving, car speeds still were limited by brake fading. However, exposed brakes such as these are vulnerable to mud and water—something that could not be accepted in passenger-car brakes.

In Europe, many changes are made in brakes to adapt them to the requirements of road competition.

Reid Railton, for example, has applied aerodynamic brakes to his record-breaking car. (A flap on the roof can be raised when stopping.) Car makers in Italy have experimented with drums having built-in centrifugal blowers that pull air through the brakes. An automatic brake distribution control is now being tried by some Europeans. This device adjusts the relative amount of braking between front and rear, depending upon weight shift. It has also been used to vary the braking between the two sides of a car when rounding a turn. (This could be a very useful device on cars for providing equal front and rear braking for low deceleration stops, thereby lowering the thermal requirements of front brakes.) Wire wheels

# a Break!

**BRAKE SPECIALISTS . . .**

**. . . who served on the Passenger Car Brakes Round Table. This article was developed from their discussion.**

**A. E. Kimberly,** Chairman
Chief Engineer
DeSoto Division
Chrysler Corp.

**W. R. Rodger,** Secretary
Supervising Engineer
Mechanical Laboratories
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**D. P. Dyer**
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Manager, Wheel and Brake Development
Goodyear Aircraft Corp.

**G. T. Ladd**
Chief Engineer
Al-Fin Division
Fairchild Engine & Airplane Corp.

**A. C. Sampietro**
Advanced Engineering Section
Willys-Overland Motors, Inc.

**T. H. Thomas**
Manager of Automotive Engineering
Bendix Products Division
Bendix Aviation Corp.

are being used, together with open backing plates, to obtain more cooling. In the interests of greater pedal reserve, automatic lining wear adjusters are receiving more attention. Special heat-resistant linings are being used which fade less.

Unfortunately, however, some of these ideas add such complications as to be unwarranted for general use on American cars.

Aircraft brakes today are primarily of the disc type. On most designs, steel is used instead of iron (even though its friction coefficient is about 25% less) to prevent shrinkage and heat checking. The low friction value of steel detracts from its desirability as a passenger-car brake material, however. Also aircraft types of disc brakes have low effectiveness.

An old device now being applied to aircraft might be applicable to passenger cars, too. This is a non-skid unit which allows each wheel to be controlled at its maximum tractive condition. Aircraft tests have shown that this type of control will appreciably shorten stopping distances. And truck tests have shown that it will greatly enhance safety by lessening the chances of skids and jackknifing on slippery roads. Use of such a device on passenger cars, when coupled with non-self-energizing car braking, would provide an automatic and safer braking system which would probably be much more efficient than the most expert manual control now possible.

Brake linings on the latest high-speed railcars are applied in short segments on steel shoes. They are mounted on rubber inserts to provide more uniform contact distribution—a very important factor in increasing brake capacity. This would be impractical on cars, however, due to attendant compression and increased pedal travel.

Thus, it can be seen that there are relatively few design features and materials in aircraft, railroad or racing-car brakes which can be applied directly to present-day passenger cars. Low fade linings usually score drums and squeak; aircraft types of disc brakes have low effectiveness; exposed brakes are vulnerable to mud; and steel (for drums or discs) has a low friction value.

Considerable support was evidenced in the discussion, however, for the prediction that brakes of the future may be larger (probably wider), with a moderate increase in their heat dissipating ability through the use of finned drums. Power assistance will probably find more widespread application, perhaps by using less unit brake output to assist in gaining other beneficial characteristics. Improved lining materials will very likely result from the current rigorous development programs. But since critical temperatures of common lining substances are exceeded even now, cooling will be mandatory.

# Sheet-Steel Drawability

A SIMPLE test has been devised for determining the drawing quality of sheet and strip steel and its freedom from stretcher strain. Two instruments are used to perform the test: the Flex-tester and a specially designed spherometer.

### Flex-Tester

The Flex-tester (shown in Fig. 1) is used to determine the force required to bend a corner of the sheet through a given arc. Its principle of operation is based on an observation long known to press and die men, who often bend the corner of a sheet to "feel" its resistance. Usually, the greater the effort required to bend the corner, the poorer its extra-deep drawing qualities will be. Some operators become very adept at predicting press performance by such means. The method is convenient but at best only roughly qualitative.

The resistance of the sheet to the bending force causes a tongue portion of the Flex-tester, acting as a cantilever spring, to deflect. This deflection is recorded on a dial gage in what are arbitrarily termed F units.

In order to obtain comparative F values, a correction for sheet thickness is required. An investigation of the mechanics of the bend indicated that this correction should be in proportion to the square of the thickness. Such a correction was found to be satisfactory empirically. As 0.035 in. is the most common thickness, it was made the standard for which no correction is required. The correction for other thicknesses can be obtained from the following formula:

$$\text{Corrected F value} = \left(\frac{0.035}{\text{Actual thickness}}\right)^2 \times (\text{F units from dial})$$

The conversion to the corrected F value is readily made by using a table of values, a slide rule, or a nomogram rather than by arithmetic substitution in the above formula.

### Spherometer

The spherometer is used to measure the degree of curvature of the bend produced by the bending force. It appears that the radius of the bend under standard conditions is closely related to the yield-point extension. It is also known that the tendency to stretcher strain is directly proportional to the amount of yield-point elongation observed during a tension test. Thus, curvature of bend should be a measure of the tendency to stretcher strain.

The spherometer (shown in Fig. 2) actually measures the maximum curvature of the flexed corner. The highest dial unit obtained is the deflection of

Fig. 1—Flex-tester being used to determine force required to bend a corner of sheet through a given arc

Fig. 2—Specially designed spherometer being used to measure maximum curvature of bend

# Measured by New Technique

**C. B. Buker and J. R. Speer,** Jones & Laughlin Steel Corp.

Excerpts from paper "A New Test for Drawability of Sheet Steel" presented at the SAE Annual Meeting, Detroit, Jan. 12, 1953. Complete paper appeared in 1953 SAE Transactions.

the material in 0.001 in. across the span of the two outside instrument points. The dial units have been arbitrarily termed R values.

### Application

Enough experience has been gained using the Flex-tester and the spherometer to warrant certain conclusions as to their value and recommendations as to their use.

R values provide the mills and stamping plants with the first production test to determine stretcher-strain characteristics.

Flex values will indicate most suitable stock for direction to a given application. This is particularly advantageous where stock sizes are used for more than one part.

Estimates of quality can be made at receiving time at a stamping plant. A consideration of aging changes then permits the immediate use of borderline material and the storing of better material for later use.

Flex values can be used to show the changes in rate and degree of aging in strip steels. For example, materials with low flex values a few weeks after mill tempering are probably of the nonaging type.

R values will show whether a cold-reduced material can be directly applied to smooth-surface parts, or whether a roller level pass is required prior to stamping. The jump-roll of the sheet processor should be used only when R values indicate it to be necessary.

During various series of tests in stamping plants it was found that results with deep-drawn parts could be improved by delivery to operations of material having F values within a reasonably close range. Attempting to stamp material of scattered F values caused delays for die adjustments with unnecessary scrap and salvage. Material for die spotting should have an F value in the range required for production purposes. Dies spotted with exceptionally low F values may not be suitable for production materials, while excessive die spotting time could be eliminated by selecting steels with F and R values in the desired bracket.

The future for the test appears very promising in both strip mills and stamping plants and should provide a tool for research investigation as well as a welcome addition to control methods.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

### Why New Test Was Needed

THE two most desired characteristics of sheet and strip steels are good drawability and freedom from stretcher strains.

In the past, drawability has generally been estimated by hardness and cup ductility tests. Evaluation of stretcher strain has required a tensile specimen from which yield behavior is studied.

Such procedures leave a great deal to be desired in production line testing, where volume, convenience, and speed are essential. They are generally time-consuming, destructive in character, and extremely localized as to test result. Due to aging, the test result is often not indicative of the quality of the material at the time of its use.

The test described here, on the other hand, requires no specimen preparation, so that it can be applied to the raw material. It is simple and convenient to use, and it is nondestructive.

# How to Hit a Homer

YEARS ago, designing a bearing was just a matter of using the appropriate PV factor, but it's no where near that easy any more. Today a whole flock of variables—load, speed, clearance, length, diameter, oil viscosity, oil flow, temperature rise, and so forth—must be considered.

To come up with a homer in the bearing-design league, a bearing designer must touch all these bases in order:

- Bearing material
- Bearing oil grooving
- Bearing clearance
- Bearing housing design

### 1st Base—Selection of Bearing Material

Before he can get to what we shall call first base (selection of bearing material), a bearing designer must determine the lay of the land. He must find out such things as expected bearing loads, operating conditions (temperature, dust and vapors, fuels and lubricants, and so forth), and life expectancy of the bearing.

Loads on the bearings of an internal combustion engine are determined from the vector sum of the gas forces and the inertia forces. Crankpin loads are found first, then these are used to get the forces on the main bearings.

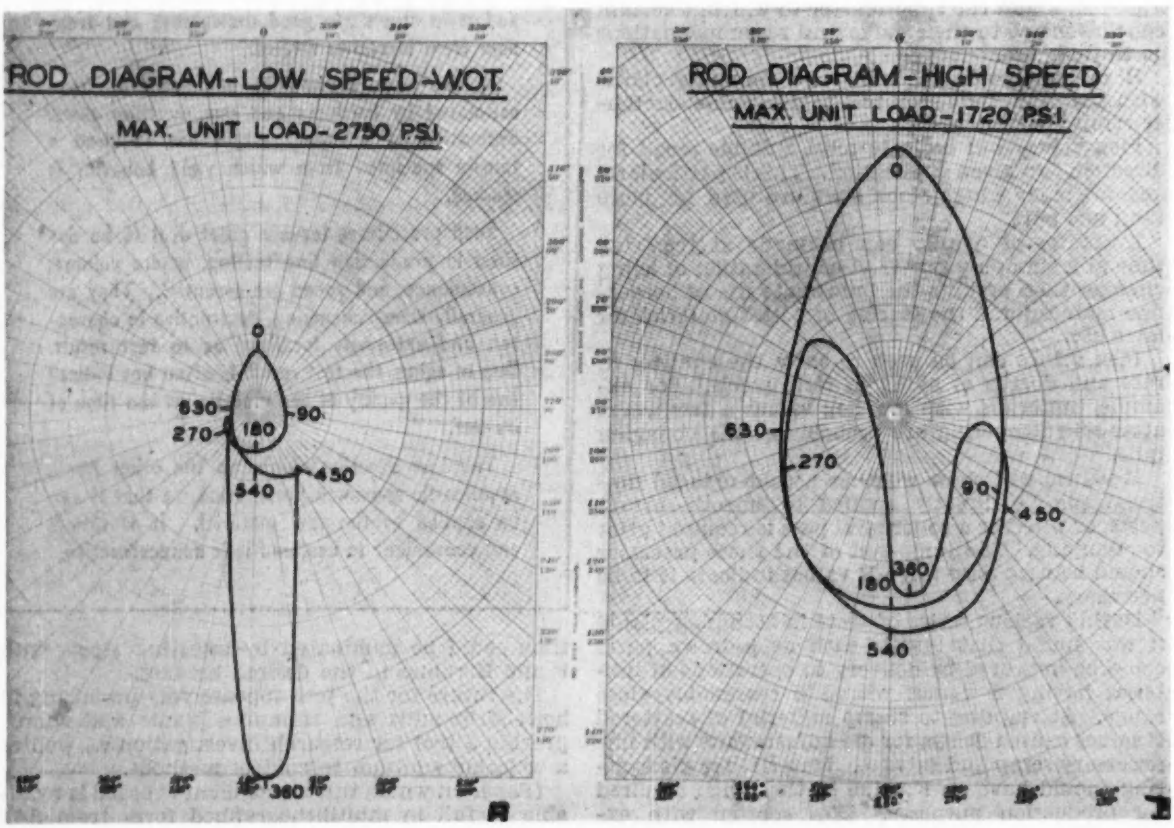


Fig. 1—These diagrams show the effect of engine speed on the magnitude and direction of the maximum rod bearing load. The plotted values are the vector sum of the gas forces and the inertia forces

# in the Bearing-Design League

**E. Crankshaw and R. C. Savage,** Cleveland Graphite Bronze Co.

Based on paper, "Latest Engineering Techniques in the Bearing Industry," presented at a meeting of the SAE Chicago Section, Chicago, Feb. 10, 1953.

Gas forces are obtained from the familiar indicator diagram. Inertia forces are computed from the weights of the reciprocating parts and the unbalanced rotating weights. The combined effect of all these forces on the crankpin is generally plotted as shown in Fig. 1. (These diagrams also show the effect of engine speed on the magnitude and direction of the maximum load.)

Knowing the rod bearing loads, the unbalanced weights on the crankshaft, the distance between bearings, and the firing order, it is possible to plot the main bearing loads. Fig. 2 is a typical main bearing load diagram for a V-8 engine.

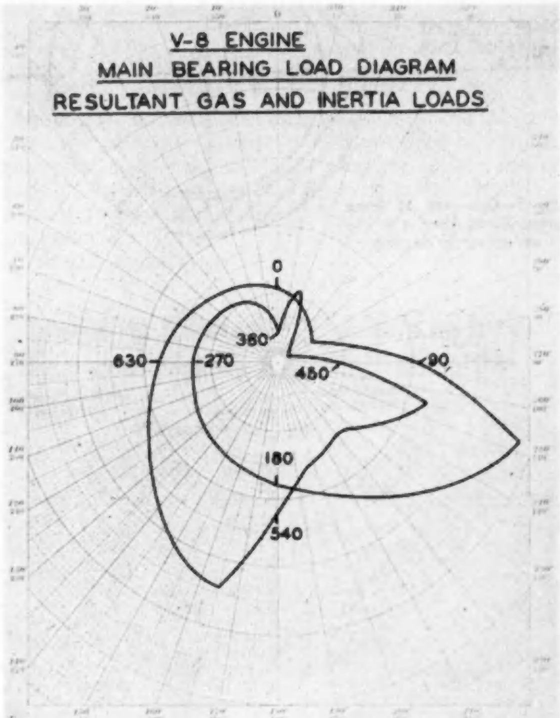


Fig. 2—Knowing rod bearing loads, unbalanced weights on the crankshaft, distance between bearings, and the firing order, it is possible to plot the main bearing loads. A typical main bearing load diagram for a V-8 engine is shown above

The shape of the main bearing load diagram is often just as important as the maximum value obtained from it. If the loads do not change much in magnitude throughout the circumference, they can be troublesome even though they are not excessive. This is particularly true of the center main bearing where there is a heavy load at the parting line, and shaft whip, deflection, and thermal distortion are greater than on any other bearing. All these facts must be considered in determining clearance, spreader groove dimensions, and chamfer.

Actually, it is impossible to establish permissible bearing loading values for various applications since consideration must be given to so many controlling variables. However, an indication of relative load-carrying capacity of various bearing materials can be obtained from carefully controlled laboratory tests. (See Fig. 3.)

### 2nd Base—Settling on Oil Grooving

Having decided what bearing material is to be used, the bearing designer then moves on to second base by settling on the necessary oil grooving.

This may or may not call for the introduction of spreader grooves and parting line chamfer. (Fig. 4 shows what is meant by a spreader groove; Fig. 5 is an illustration of parting line chamfer.) If it is necessary to find ways to keep bearing temperatures down, then these devices may well be used. Still another approach to the high-temperature problem is to give the bearing more horizontal clearance at the parting line than exists in the vertical direction. (See Fig. 6.)

Experience has established the fact that a bearing will usually operate satisfactorily if it can be kept cool enough. (Excessive heat reduces both fatigue life and hardness and compressive strength of a bearing. Fig. 7 shows how rapidly fatigue strength falls off with increased temperature; Fig. 8 shows reduction in hardness and compressive

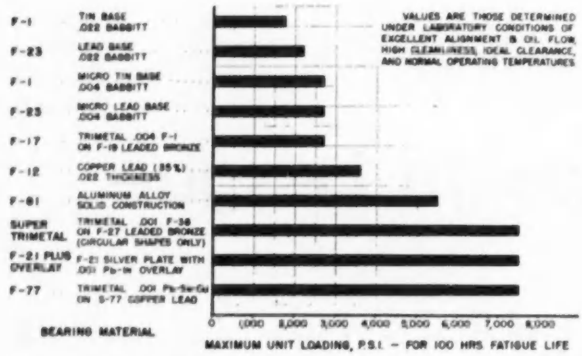


Fig. 3—Relative load-carrying capacity of various bearing materials

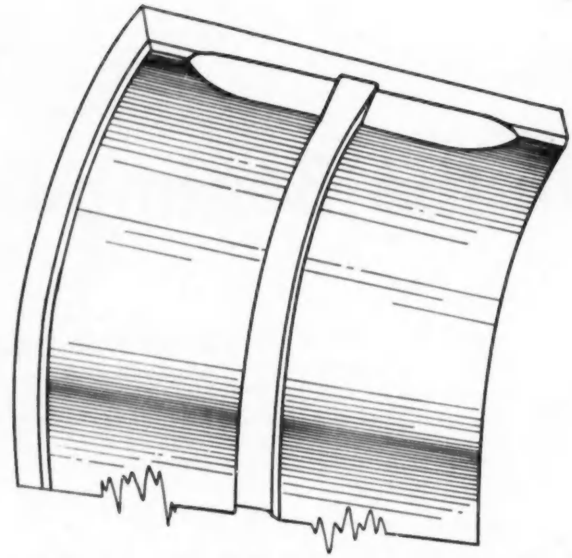

Fig. 4—This shows a spreader groove and chamfer at the parting line

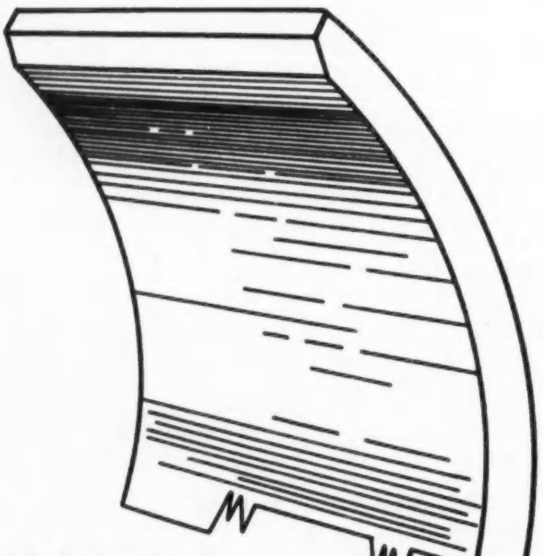

Fig. 5—This shows what is meant by parting line chamfer

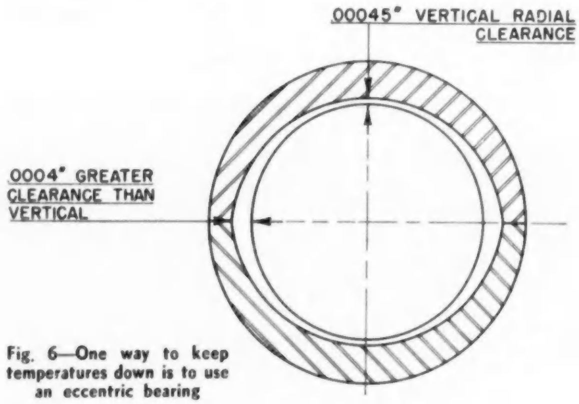


Fig. 6—One way to keep temperatures down is to use an eccentric bearing

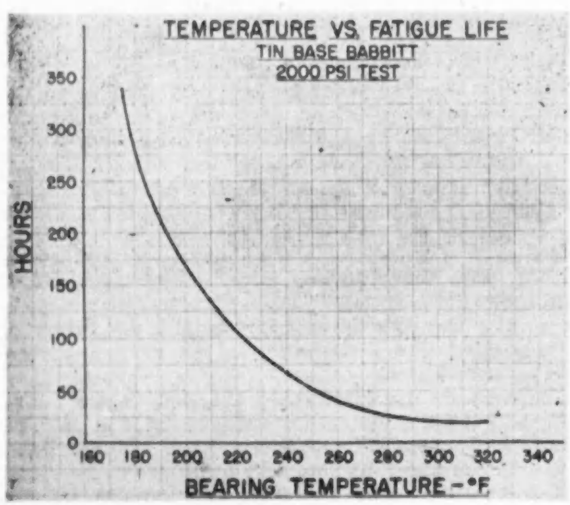


Fig. 7—Fatigue life of bearing materials falls off rapidly with increased temperature

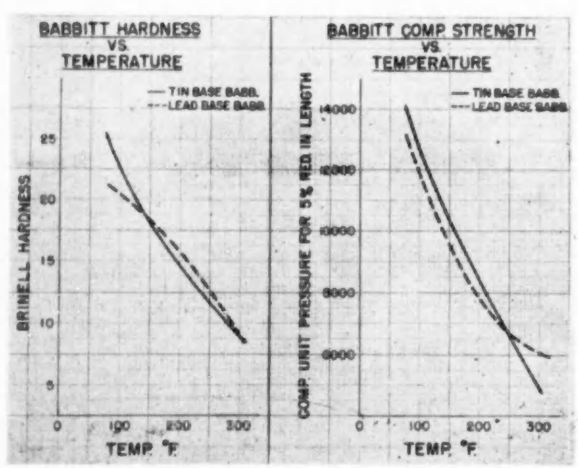


Fig. 8—Hardness and compressive strength of bearing materials decreases with increase in temperature

strength with increase in temperature.) Thus a lubrication study should be made to establish probable bearing temperatures . . . and to investigate ways to reduce these expected temperatures.

### 3rd Base—Determining Necessary Clearance

While circling into third base, the bearing designer must determine what bearing clearance range will best keep bearing temperatures down.

Knowing the bearing load, length and groove dimensions, shaft size and speed, probable oil sump temperature, grade of oil and its supply pressure, he can find reasonable values of the following for various clearances:

1. Effective oil viscosity
2. Rate of oil flow
3. Friction torque and accompanying power loss
4. Oil film thickness
5. Bearing temperature

Fig. 9 shows a typical graph of bearing temperature and oil film thickness, both plotted against clearance. Notice that the clearance range recommended by Cleveland Graphite Bronze is displaced to the right about 0.0012 in. from the clearance range suggested by the engine manufacturer. This range will give the bearing a thicker oil film and permit it to operate at a lower temperature, both of which are desirable.

In addition to this, it is a know fact that of all bearing failures, the greatest number by far are caused by foreign material in the oil. This fact makes it increasingly important to design bearings so as to attain the maximum possible oil film thickness.

### Home—Coming Up With a Suitable Housing

Having selected a suitable bearing material, determined the oil grooving, and decided upon an appropriate clearance, the bearing designer is ready to swing into home. Getting to home in the bearing-design league means making sure that the bearing will maintain its shape when it is installed in the customer's engine.

**The bearing manufacturer of 1953 faces a multitude of design requirements which were nonexistent thirty years ago. Today a bearing must:**

- **Perform at higher temperatures**
- **Resist higher loads repeated at increased rates.**
- **Conform to its shaft for good "run-in"**
- **Absorb abrasive particles without damage**
- **Resist corrosion and disintegration from action of certain oils.**

**Yet the bearing must be simple, easy to make, and priced so that it will sell.**

**How the bearing manufacturer of today meets these requirements is described in this article.**

To accomplish a tight fit between the bearing shells and the rod or crankcase bores, each half shell should be made slightly longer than a semicircle. This difference between the length of arc on the bearing back and the length of the arc of the bore is called crush. Crush is illustrated in the left view of Fig. 10. Tightening the cap bolts closes the gap between the cap and rod with the result shown in the right half of Fig. 10.

The bearing now fits snugly in its housing, but some deformation has taken place which, depending on housing yield, may or may not be serious. But this is not all. If high inertia loads exist on

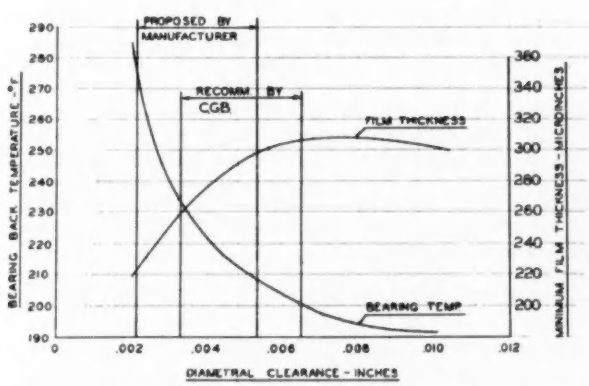


**Fig. 9—This is a typical graph of bearing temperature and oil film thickness, both plotted against bearing clearance. Important thing to note here is that moving the clearance range to the right gave this bearing a thicker oil film and permitted it to operate at a lower temperature**

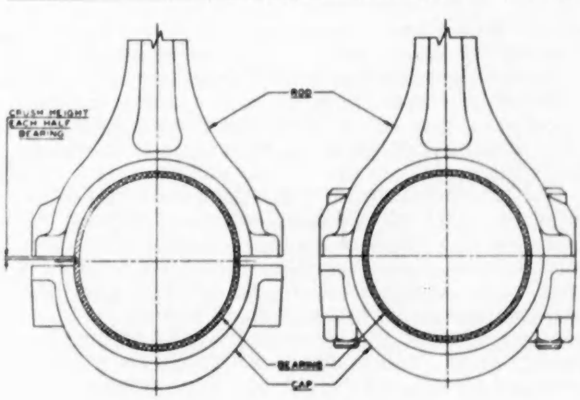


**Fig. 10—This shows what is meant by bearing crush**

the cap, as was shown in Fig. 1b, there will be a tendency for the bearing diameter to elongate in the direction of the rod and close in at the parting line.

To help decide if an eccentric bearing (see Fig. 6) should be used or whether a change in housing design is necessary, bore distortion studies are made from actual measurements taken from loaded housings.

Further complications are introduced if a customer wants to reduce engine weight by using a light metal, such as aluminum, for the housing. This is especially true if the equipment must operate over a wide temperature range. Take, for example, the case of a steel-backed bearing placed in an aluminum housing at room temperature, with the engine itself expected to start at -65 F . . . and anticipated bearing temperature to be as high as 320 F. Because the expansion of aluminum is almost twice that of steel, to get satisfactory performance considerable attention would have to be given to the mass of the housing, the size of the bolts, and the press fit of the bearing.

With the bearing material selected, the oil grooving determined, the clearance established, and reasonable assurance that the bearing will maintain its dimensions when assembled, the chances of service failures have been reduced to a minimum. The bearing designer has hit a home run in his league!

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Departemnt. Price: 25¢ to members, 50¢ to nonmembers.)

# Vapor Lock . . .

## . . . problem is analyzed broadly in an attempt to reduce the subject to a few simple engineering charts.

Digest of paper by **T. W. Legatski, O. C. Bridgman, E. W. Aldrich, and R. Rohde**
Phillips Petroleum Co.

A DISCUSSION is given on the evaluation, correlation, interpretation, application, and significance of vapor-lock test data.

The evaluation of vapor lock is normally made by the so-called soak-type procedure, in which the fuel system of the vehicle is allowed to soak up heat from the engine after a prolonged run at high speed, and prior to a full-throttle acceleration to test for the occurrence of vapor lock. The procedure is reproducible, but more severe than normal operation by the average driver. The difference in severity is evaluated by comparison of the vapor-locking tendencies of a large number of vehicles by the soak-type procedure but on fuels that give acceptable freedom from vapor lock in service.

The correlation of observed vapor-lock data to a comparable reference state of sea level and 100 F ambient temperature is illustrated, based on the use of simple conversion charts previously developed. Where two or more fuel types are tested in a given vehicle, a plot of the Reid vapor pressure values at the reference state against the 10% point slope as the fuel characterizing variable permits drawing a line of equal vapor-locking tendency. This line is called an isovapor-lock line. It constitutes the basic concept of the analysis.

The interpretation of vapor-lock data is formulated in terms of practical variables, namely the intercept and slope of the isovapor-lock line. The intercept, expressed in terms of a derived scale designated as fuel system index, characterizes the basic quality of the fuel system. The index is independent of the $V/L$ ratio (vapor-liquid volume capacity) of the fuel system, and from observed fuel temperature measurements, the fuel system pressure drop can readily be evaluated. The slope of the isovapor-lock line, defined as the difference between the intercept and the value at which the 10% point slope equals 4, is designated as the fuel system sensitivity. From observed values of fuel temperatures, a simple chart permits evaluation of the $V/L$ ratio from the fuel system sensitivity.

The application of vapor-lock data to fuel system design problems is treated from the standpoint of the relative importance of fuel system temperature, pressure drop, and $V/L$ ratio. It is shown that increase in $V/L$ ratio does not affect the fuel system index and affords only minor improvement in fuel system sensitivity. On the other hand, an increase in fuel system index through lowering the temperature rise or decreasing the pressure drop, automatically produces an overall gain in fuel system characteristics. A simple test method is proposed for direct evaluation of the fuel system index through the use of reference fuel blends having essentially zero 10% point slope.

The significance of test data on only one vehicle of a given make and model is questioned. Information is presented showing wide spreads between the vapor-locking tendencies of different vehicles of the same make and model. In contrast, the corresponding spread between competitive fuels is shown to be only about one-half as great as between vehicles of the same make and model, or only about one-third as great as between different makes and models on the road. The significance of the Reid vapor pressure method is questioned as regards its direct application to vapor-lock problems, without regard to other fuel characteristics, and a modified method at the same test temperature but at higher $V/L$ ratio is proposed for consideration.

(Paper "Fuels and Fuel Systems—A Petroleum Viewpoint" was presented at the SAE Summer Meeting, June 11, 1953. Complete paper is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)


**M. H. Joyce Jr.,** Budd Co.

Based on secretary's report of Panel on Precision Forming and Joining held as part of the Aeronautic Production Forum at the SAE Aeronautic Meeting, New York City, April 20, 1953. Leader was Michael Watter, Budd Co.

MANY tips on how to do a better job of welding and brazing were presented at this session. The panel members also discussed forming methods and sheet-metal design.

## Resistance Welding

***Question: In spot welding machined members, what surface finish is required and why?***

Answer: When pressure is applied by the welding tool and the metal temperature is raised, the surrounding area must compress sufficiently to seal the molten pool. If the surface is too rough, molten metal will be allowed to seep or squirt out of the weld area, resulting in poor welds. The commercial finish on rolled sheets (usually 32 to 63 microin.) appears to provide adequate surface requirements in the majority of cases.

One participant reported that a slightly rough surface—as from a very light sandblast—sometimes proves better than a smooth surface finish in seam welding stainless steels. This has been attributed to improved current density.

***Question: What are the limitations of spot welding aluminum with a single-phase machine and how does a 3-phase machine increase the potentialities?***

Answer: It was generally agreed that, wherever possible, a capacitor-type machine, where a high voltage and a rapid discharge are employed, should be used for spot welding aluminum, since a high energy input for a short interval of time is necessary. It was pointed out that the 3-phase a-c machines were developed for welding hi-alloys and stainless steel, and are not designed for welding aluminum, but that they would produce better results than single-phase machines.

***Question: For projection welding, should the projections be formed in the thinner material?***

Answer: A considerable number of participants agreed that placing the projections in the thinner material has resulted in improved welds on many applications, this procedure being contrary to the metallurgists insistence that the projections be placed in the heavier stock to insure that the projection will not be burned off before the flat material has been raised to correct fusion temperature. One particular company, which allows projection welds only

on secondary members, invariably places the projections on the thinner material.

## Inert Gas Shielded Arc Welding

***Question: In butt-fusion joints, when is filler metal required and when may it be omitted?***

Answer: When dissimilar metals that do not alloy well with each other are being joined, filler metal is a must, and in this case it is obvious that a careful selection of a third metal, which alloys well with each parent metal, must be made.

One company prefers to employ a filler metal in almost all cases, while another company reported an economic gain was possible in many cases where it was possible to hold the butt-joint gap to a minimum. Where flush welds are required, it was reported that the use of filler metal required a grinding operation, in many cases, while a joint without filler metal was accepted without further operations.

Another company has found that when forming operations are required after welding, the pieces are more likely to crack along the welded joint when filler metal is employed.

***Question: To what value of yield stress does a 61S aluminum-alloy butt-fusion joint fall?***

Answer: A drop in yield to 60% of the initial parent metal yield was reported, which, by proper heat-treatment, can be brought back up to 90%.

## High-Temperature Brazing

A general discussion was held under this topic, chiefly centering around the brazing of stainless steels.

Where high resistance to corrosion and good strength at high temperatures are required, brazing with Nicroloy at 2050-2200 F is generally employed. This process must take place in a pure dry hydrogen atmosphere, all traces of oxygen and water vapor being previously removed. In continuous processes, the parts are usually carried vertically in boxes through the oven, which must be equipped with door openings of minimum size, so that no air is admitted to contaminate the hydrogen. In the presence of the high temperature and hydrogen atmosphere, the oxids are reduced and the parts take on a bright finish. The dew point of the hydrogen gas must be at least -20 F for stainless-steel parts containing less than 10% Cr. For stainless steels containing more than 10% Cr the dew point of the hydrogen gas must be -80 F to -100 F going into the oven and not higher than -50 F coming out. The furnaces are uninsulated so that moisture will not develop on the refractory and contaminate the hydrogen gas. In batch process work the parts to be brazed are usually placed in metal retorts into which the pure hydrogen is blown.

Where strength at high temperatures is not required, and where there is no disadvantage due to surface nitriding, copper brazing is employed. In this process, a dissociated ammonia atmosphere can be used, which is much cheaper than bottled hydrogen.

One participant mentioned a brazed assembly of monel, inconel, and type 4387 parts, which could not be placed in an oven due to the incorporation of some glass beads as part of the assembly. This particular assembly was Nicrobrazed successfully and cheaply in an induction heating machine. The parts around the glass beads were water cooled while the assembly was placed under a glass beaker into which the pure dry hydrogen was blown.

Another example was cited where platinum electrodes were brazed successfully to inconel as part of experimental spark plugs. No inert atmosphere and no flux were used in the process. The brazing material was a paste made of Acroloy powder and electrical resistance used to obtain heat at the joint.

## Forming Methods

***Question: What are some of the newer methods for the extremely accurate fitup required in the sheet-metal construction of aircraft engines?***

Answer: Because of many existing heat-treatment requirements, most materials should be completely annealed before assembling.

In the case of Timken alloy 1722AS, one company finds that heat-treating the parts before welding, *then* tempering, improved dimensional retention.

Most new designs coming off the boards stress butt-fusion welding in preference to lap spot welding.

Parts that cannot be formed from a flat sheet are sometimes preformed, then welded and the forming continued. Unit design with proper stress-relieving and subsequent heat-treatment is extremely important. More expensive tools are required to hold work during welding and heat-treating operations.

***Question: How are the inside diameter at one end of a sheet-metal cylinder and the outside diameter of the opposite end held in forming when a roller seam-welded joint is called for?***

Answer: The material specifications may have to be revised to call for closer tolerances on thickness. The contact pressure of roller welding may usually be so adjusted as to eliminate shrinkage and obtain proper diameter tolerances. It may be necessary to require sheet-metal workers to roll out each cylinder individually to meet tolerances.

***Question: Is it possible to spin aluminum-coated steel without having the aluminum coat flake off?***

Answer: Considerable study is now going on. At the present time aluminum coatings tend to flake easily when they are under confinement during forming. Spinning of this material is being successfully performed in certain shapes where excessive compression can be avoided in the operation. It was mentioned that the material will stretch up to about 5%, although an-

other participant reported 20% stretch as a maximum.

It was generally agreed that the preferred method—to be used wherever possible—is to form the part first and then coat with aluminum.

A general discussion was held on the press-working of metals. One participant expressed the belief that many manufacturers are going in the wrong direction by forming metals with slow-acting presses. He reported that recent experiments indicate that when using properly designed tools and dies in good operating condition, there is no limit to the speed of drawing in so far as the material is concerned. So long as the yield point has been successfully exceeded and the material is in the plastic range the participant claimed that there was no limit to the speed of deformation.

It was mentioned that dipping a blank in metallic lead for lubrication has eliminated 50% of the deep-draw operations on a particular piece. Phosphorous coating has also been used successfully as a lubricant on cold extrusion work and deep draws.

## Sheet-Metal Design

***Question: When ceramic coating is applied at 1750 F, what effect is produced on previously heat-treated material?***

Answer: The ceramic coating is not applied after heat-treating but is applied either as part of the heat-treating cycle or before heat-treatment.

***Question: Why are stainless steels and titanium usually rated lower in structural efficiency than aluminum alloys by most aircraft engineers?***

Answer: On a theoretical basis, stainless is probably just as efficient as aluminum but it is more difficult to have every member of a stainless structure take its share of the load. Usually, a 10% weight reduction can be obtained with a proper aluminum design. In a stainless-steel structure very light cold-rolled gages must be used with a great deal of stiffening, and labor costs are very much higher. It was generally agreed that titanium probably lies somewhere between the two regarding structural efficiency, but information on this material is too spotty at the present time.

***Question: At what temperature range does the structural efficiency of stainless steel drop off?***

Answer: Up to about 1000-1100 F, the drop is in the order of 10%. Above this temperature range the efficiency starts to drop rapidly. Usually, the ultimate strength of the material at a given temperature is the only characteristic requiring consideration, since the particular stress-strain relationship remains similar to that found at room temperature.

***Question: What is the tensile strength of Timken sheet stock 1722S?***

Answer: In the spherodized annealed state (96-hr anneal) the ultimate strength is 85,000 psi with a 10% to 20% elongation in 2 in. When heat-treated to a hardness of Rockwell 26-32, the ultimate strength is 140,000 psi with a 2% elongation in 2 in.

One company forms this material to approximately ½% undersize, then anneals before restriking to size tolerance.

***Question: Do the tolerances generally called for on precision formed parts exceed the functional requirements?***

Answer: In most new applications, extremely close tolerances are demanded until the first assemblies are completed and tested, after which the tolerances are relaxed wherever possible. However, it was pointed out that the designer should be thoroughly cognizant of what each drawing notation means to his particular shop. Such notations as "drill," "ream," and "slide fit" infer specific tolerances in many shops and therefore must be used with care.

One company actually requires the signature of a representative of the production department on each part drawing before release to the shop.

**Members of Precision Forming and Joining Panel**

**Michael Watter,** Leader
Director of Research
Budd Co.

**M. H. Joyce Jr.,** Secretary
Research Engineer
Budd Co.

**Jesse S. Sohn**
Section Head, Process Research & Development
Curtiss-Wright Corp.

**Walter H. D'Ardenne**
Chief Engineer—Research
Heintz Mfg. Co.

**H. M. Webber**
Application Engineer
General Electric Co.

**Frank J. Gardiner**
Chief Engineer
Special Products Division
ITE Circuit Breaker Co.

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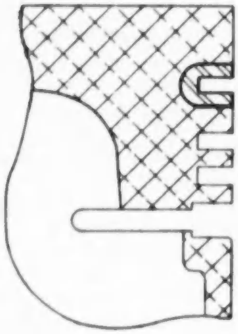
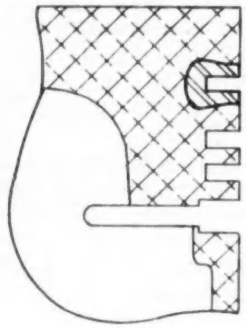
(The report on which this article is based is available in multilithographed form together with reports of the nine other panel sessions of the 1953 SAE Aeronautic Production Forum. This publication is available as SP-302 from the SAE Special Publications Department. Price: $2 to members; $4 to nonmembers.)

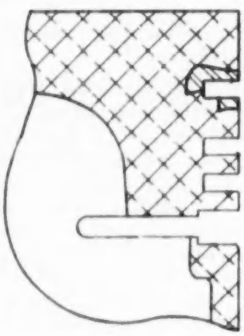
# Cast-In Inserts End



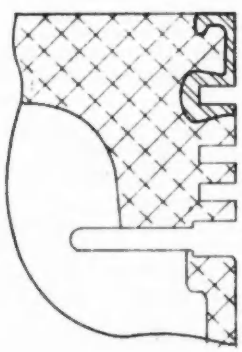
The parallel-side insert depends solely on the bond between the aluminum and the insert to keep the insert tight. For successful bonding, the insert material must have a high coefficient of expansion approximating that of the aluminum. No field failures have been found when the insert bonded properly during manufacture. But when the insert does not bond properly during the casting process, failure is likely to occur.



Dovetail-shape inserts achieve a mechanical lock as well as bonding. Besides, the aluminum pulls in the insert, reducing the stress carried by the bond during the cooling of the piston casting. This design has been widely used for both cast iron and austenitic iron inserts. Caterpillar Tractor reports they've experienced no failures among their several hundred thousand aluminum alloy pistons with cast iron dovetail inserts, despite the difference in coefficients of expansion.



Machining the ring groove of this type of bonded insert notches it. The result is that the insert exerts spring tension on the aluminum. In production, most inserts of this design have been made of austenitic iron.



This style of bonded insert has been used for two-cycle engine pistons. The insert protects the entire top land from the very hot gases which might otherwise burn away the aluminum.

# Groove Wear Troubles

**J. W. Pennington,** Koppers Co., Inc.

Based on secretary's report of round table on Cast-In Groove Inserts as a Solution to the Groove Wear Problem held as part of the SAE Summer Meeting, Atlantic City, June 10, 1953. Chairman was A. M. Brenneke, Perfect Circle Corp.

THE cast-in groove insert has been a universally successful solution to the problem of top groove wear in aluminum pistons. On this point, there was general agreement at the round table discussion on cast-in groove inserts at the SAE Summer Meeting.

Cast-in inserts were used experimentally in the 1920's and early 1930's when the groove wear problem in aluminum pistons for high-output engines began to appear. As engine outputs and piston temperatures have increased, the problem has become common and the same solution has been applied. Caterpillar Tractor Co. started using an assembled piston with a cast-iron top groove carrier in production starting about 15 years ago. Since then the four design approaches described in the accompanying box have been used.

All four of the designs shown apparently have operated successfully in the field. Tests have been run with unbonded inserts, but as far as discussion participants knew, no production use is being made of unbonded inserts at the present time.

With bonded inserts, one of the most difficult problems is to determine if a good bond has been obtained between the insert and the aluminum piston casting. When the insert is taken from the aluminum dip prior to casting of the piston, a scratch test will determine if the aluminum coating has bonded to the insert. However, the most serious problem seems to be the formation of an oxide film on the aluminum coating of the insert which prevents the bonding of this coating to the aluminum piston casting in the mold.

The most successful test for bond seems to be the use of a dye penetrant on the edge of the insert after the piston has been turned. Various sonic methods have been tried but have not been successful to date.

Evidence was presented to show that the use of an insert increases the piston crown temperature, probably by reducing the path for heat flow from the crown. In so far as this would reduce the top ring groove temperature, it would be advantageous. Special means for additional crown cooling might, however, be necessary.

**Ideas reported in the accompanying article were voiced at a round table discussion for which the panel consisted of:**

**A. M. Brenneke,** Chairman
Perfect Circle Corp.

**J. W. Pennington,** Secretary
Koppers Co., Inc.

**Richard Frank**
Caterpillar Tractor Co.

**George Ladd**
Al-Fin Division
Fairchild Engine & Airplane Corp.

**James Smith**
Aluminum Co. of America

**Malcolm Smith**
Zollner Machine Works

**Ray Sulprizio**
United Engine and Machine Co.

# Design Changes Affect

THE effect of several design changes on direct operating costs of commercial airplanes can be calculated from the formula given in Table 1. This formula can be used for all three types of engines—reciprocating, turboprop, and turbojet—by applying the proper constants, which are also included in the table.

To develop this material, example domestic designs were set up, using comparable luxury levels, size and date of manufacture and of operation. ATA formulas were used, where applicable.

This formula was then used to examine the effect of variations in basic cost variables. Range and payload were held constant and the effects of the variations listed below were examined, one at a time.

1. Increase operating weight empty by 10%. To show the minimum effect and to make results applicable to an engine discussion, it was assumed that:

a. The weight increase occurred in equipment (such as engines) a considerable distance out on the wing span.

b. The airplane was not critical at take-off, so that the take-off weight could be increased without increasing take-off thrust.

(Operating weight empty increased by 10% and take-off weight increased by the original increase in empty weight plus structure and fuel. Cruise altitude was reduced, but block speed remained almost unchanged.)

2. Reduce block speed by 20 knots. The decrease considered here could be due to an increase in design headwind or to other factors. Again it was assumed that take-off performance was not critical, and that the fuel used and take-off weight could be increased without increasing take-off thrust.

3. Increase specific fuel consumption 10%. Using assumptions similar to those above, fuel quantity was increased by 10% plus the quantity to extend the trip to a higher take-off weight for the addi-

**Table 1—Formula for Determining Direct Operating Cost of Typical Commercial Airplanes**

$$\text{Cost per mile} = \frac{A + BW + CW_a + DT + EW_o + FV_b + G(Q/R)V_b}{V_b}$$

where:

$W$ = Take-off weight, lb
$W_a$ = Airframe weight, lb
$T$ = Sea-level static power thrust, lb
$W_o$ = Operating weight empty, lb
$V_b$ = Block speed, knots
$Q$ = Quantity of fuel used, lb
$R$ = Trip length, nautical miles

| | Reciprocating | Turboprop | Turbojet |
|---|---|---|---|
| A | 30.8 | 32.4 | 31.7 |
| B | 0.000021 | 0.000021 | 0.000021 |
| C | 0.00133 | 0.00211 | 0.00189 |
| D | 0.00573 (bhp) | 0.00535 (eshp) | 0.00370 (slst) |
| E | 0.000304 | 0.000304 | 0.000282 |
| F | 0.0340 | 0.0306 | 0.0306 |
| G | 0.0369 | 0.0231 | 0.0231 |

# Airplane Operating Costs

**J. E. Steiner,** Boeing Airplane Co.

Based on paper "Effect of Engine Weight, Drag, and Fuel Consumption on Direct Operating Cost of a Commercial Airplane" presented at the SAE Annual Meeting, Detroit, Jan. 15, 1953.

tional fuel and for the structure required for the higher weight.

Results of these three changes are shown in Fig. 1.

The formula can also be used to show that a 5% increase in turbojet powerplant drag will cause an increase in direct operating cost of about 1.5%.

Many other investigations could be made, such as:

1. Conditions where take-off weight is increased as above but where engine thrust must be increased to permit the weight increase. In this case, take-off weight will be further increased by the effects of the powerplant weight required to produce the thrust.

2. Conditions where payload is decreased instead of take-off weight increased. The effect of increases in engine weight, drag, or fuel consumption may be very large if payload is reduced and direct operating costs are calculated on the basis of cost per ton-mile or per passenger-mile.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

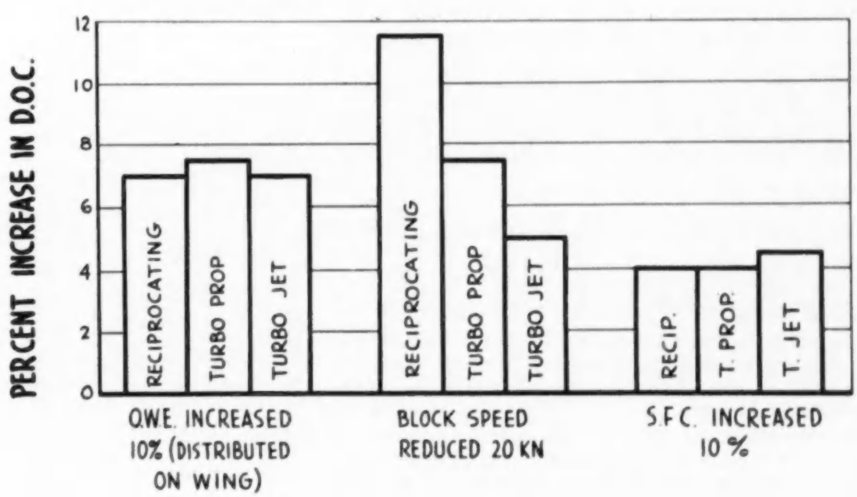



Fig. 1—Effect of weight, speed, and fuel quantity on direct operating costs of typical commercial airplanes. For this example, take-off performance was assumed not critical. If critical, above values would increase greatly

# Can's and Can't's

# of Torque Converters in

WILL torque-converter type transmissions become as popular in medium and heavy-duty highway trucks and tractors as they have in off-highway trucks, transit buses, and passenger cars? Right now it's difficult to say.

It's true that a truck driver's job would be made a lot easier with a good converter transmission design. Also, where an operator is experiencing high engine and drive-line maintenance costs, we believe a torque-converter transmission would help to reduce them.

But until a torque-converter transmission is designed specifically for medium and heavy-duty highway trucks, no one can say what initial cost and weight could be. And only experience in actual service will tell whether it would offer savings in overall maintenance costs.

To get an idea of what converter transmissions do and don't offer as drives for medium and heavy-duty highway trucks and tractors, White Motor Co. decided to road test some converter-equipped vehicles.

Before we discuss what we did—and the results we got—it might be well to define what we mean by medium and heavy-duty highway trucks and tractors. For the purposes of this discussion, then:

| | |
|---|---|
| Medium truck | 16,000 to 24,000 lb (gvw) |
| Heavy-duty truck | 24,000 lb and up (gvw) |
| Medium tractor | 30,000 to 55,000 lb (gcw) |
| Heavy-duty tractor | 55,000 lb and up (gcw) |

Also, since power to weight ratio of a vehicle affects transmission requirements, Table 1 is shown to illustrate how these classes of highway trucks compare with vehicles currently equipped with torque converters.

Now let's consider the case of a 16,000-lb gross weight truck operating in store-to-store or door-to-door delivery service in a metropolitan area. Since White manufactures a truck of this type, it was considered advisable to study what advantages and disadvantages would result from installation of a torque-converter transmission in one of them. Before trying out such a truck in actual customer service, however, we decided to run a series of tests with a converter-equipped experimental truck.

An investigation revealed that a passenger-car converter transmission could be modified slightly and adapted for our use. (This transmission has a split reaction member converter coupling, combined with a hydraulically controlled two-speed transmission and direct-drive clutch. Transmission ratios are direct and 1.82. Stall torque of the converter is 2.4 to 1. The low ratio in the transmission can be manually selected.) It was obvious, however, that the range of torque multiplication of this converter transmission would not be adequate to compare with the mechanical transmission used in the standard truck. To obtain additional gear reduction without resorting to the expense and suffer-

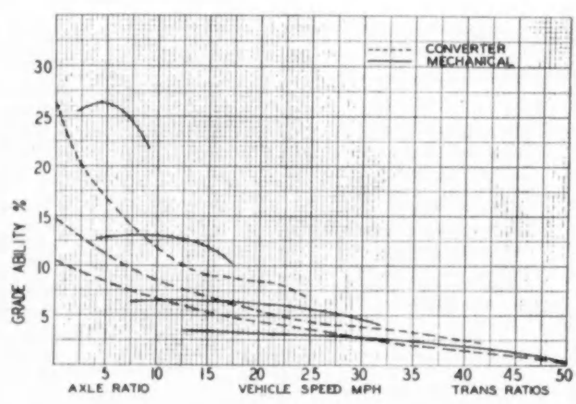



Fig. 1—Gradeability versus road speed curves for two 16,000 lb gvw highway trucks—one equipped with a torque-converter transmission, the other with a mechanical transmission

# Highway Trucks and Tractors


## P. L. Gillan and W. S. Coleman, White Motor Co.



Excerpts from paper "Advantages and Disadvantages of Torque Converter Type Transmissions for Medium and Heavy Duty Trucks and Tractors in both Multiple Stop and Long Distance Operation" presented at SAE Summer Meeting, Atlantic City, June 10, 1953.


ing the delay involved in a complete redesign of the transmission, we decided to supplement the converter transmission with a two-speed axle.

Table 2 shows the general specifications of the vehicle and both transmissions. You will note that the converter-equipped truck cannot transmit as much torque to the rear wheels in starting as the geared unit can—even when the two-speed axle is used. This, at once, indicated that the geared vehicle would have a decided advantage if heavily loaded and operated on a severe grade. A comparison of the gradeability versus road speed curves for the two vehicles further illustrates this deficiency. (See Fig. 1.) Although grades of 18 to 20% are seldom encountered in service, it is plain that the geared vehicle would provide substantially more speed under such a requirement.

Fig. 2 illustrates the computed acceleration curves for the two types of drive. It can be seen that they definitely are comparable. Note that the fast shift in the converter transmission plays an important part in the performance of this unit.

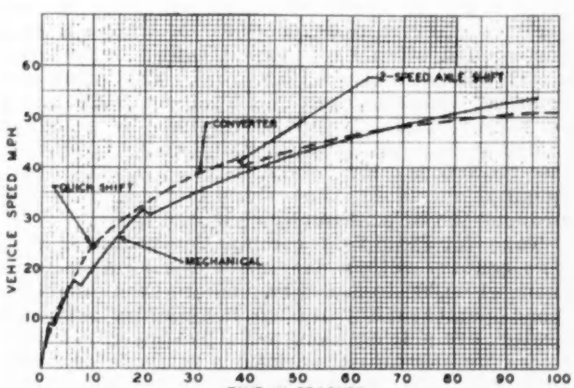



Fig. 2—Acceleration curves for two 16,000 lb gvw highway trucks—one equipped with a special torque converter and two-speed axle, the other with a four-speed mechanical transmission

### Test Results

Now let's take a look at what we found when the standard (mechanical transmission) and experimental (converter transmission) trucks were put through several tests. The results came out like this:

1. The converter-equipped truck required 31% more time to climb a one mile hill having a maximum grade of 8½%.

2. The geared unit used 22% less fuel in 500 miles of multiple-stop service which averaged two stops per mile.

3. The converter unit was much easier to handle in traffic and on snow and ice.

Although these results were not too encouraging, the converter transmission and two-speed axle were installed in one of a fleet of trucks of the type shown in Fig. 3. (This fleet was selected because (1) traffic conditions were tough, (2) terrain included many small grades, and (3) operation was

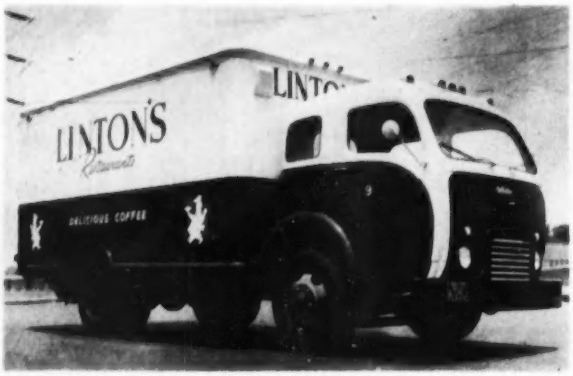



Fig. 3—The special torque-converter transmission and two-speed axle were installed on this vehicle and evaluated in actual multiple-stop service

**Table 1—Power to Weight Ratios of Trucks, Transit Buses, and Passenger Cars**

| Vehicle | Passenger Car | Off-Highway Truck | Transit Coach | Medium Truck | Heavy-Duty Truck | Medium Tractor | Heavy-Duty Tractor |
|---|---|---|---|---|---|---|---|
| Gross Hp | 112 | 300 | 200 | 114 | 184 | 145 | 200 |
| Gross Weight, in tons | 1.63 | 44.0 | 14.14 | 9.5 | 16.0 | 25 | 38.4 |
| Hp/Ton | 68.7 | 6.83 | 14.14 | 12.0 | 11.5 | 5.8 | 5.21 |

**Table 2—General Specifications of Test Truck and Its Transmissions**

Vehicle Rated Gross Weight—16,000 lb

| | |
|---|---|
| Engine | |
| Displacement | 245 cu in. |
| Horsepower at 3400 Rpm | 100 |
| Maximum Torque | 187 ft-lb |
| Tire Size | 8.25-20 |

| Mechanical Transmission | | Converter Transmission | |
|---|---|---|---|
| Axle Ratios | 6.8 | Axle Ratio High | 6.33 |
| Transmission Ratios | | Low | 8.81 |
| 4th | 1.00 | Converter Stall | 2.40 |
| 3rd | 1.69 | Transmission Ratios | |
| 2nd | 3.09 | High | 1.00 |
| 1st | 5.90 | Low | 1.82 |
| Maximum Total Ratio | 40.2 | Maximum Torque Ratio | 38.1 |

representative of multiple-stop store-to-store service.

Over a period of 10 months of service, during which the vehicle traveled 15,405 miles with an estimated average gross weight of 13,000 lb, it was found that:

1. Practically all operation in the city was in the low range of the two-speed axle. The high range was used mainly on runs to the suburbs. Percentage use of each was estimated at 75% low range and 25% high range.

2. Maintenance expense of engine, transmission, and rear axle was nil.

3. The truck was slow on steep grades.

4. Fuel consumption was 6 mpg as compared with 5½ mpg for the same truck before equipping it with the torque converter.

5. Both the equipment manager and the driver were pleased with the truck.

Except for the fuel consumption data, these results were in line with expectations. As for the improvement in fuel consumption, it might have been influenced somewhat by the fact that the operator changed from a power take-off driven tailgate to an electrically operated one at about the same time the converter transmission was installed. However, the vehicle speed at which this converter transmission locks up is inversely proportional to throttle opening. Thus, it is believed that part-throttle operation (caused by heavy traffic and only 13,000 lb gross as compared with 16,000 lb in our experimental tests) was an important factor. In any event, we know that the performance and ease of operation made a favorable impression on our customer.

Now as long as power to weight ratio remains approximately the same, it is reasonable to assume that a larger truck would give similar results in similar multiple-stop service.

Tractor-trailer operation, however, introduces an entirely new set of conditions. Here the power to weight ratio is about one-half that of medium and heavy-duty highway trucks. Consequently, lack of acceleration and flexibility in tractor-trailer combinations makes them unsuitable for multiple-stop service. Nevertheless, periods of multiple-stop service are often encountered where routes pass through large metropolitan areas. This condition, together with the requirement for maximum speed on varying grades, highlights the need for a flexible transmission. As a result, many combinations on the road today have from 8 to 15 speeds. Frequently, therefore, the driver is faced with the arduous job of continually changing gears.

Take, for example, a combination widely used in this country with a 145 hp engine hauling gross loads of 45,000 to 60,000 lb. Where such combinations operate mainly in open, flat country, some operators are getting along with five speeds. Where there are substantial variations in grade or traffic conditions, the trend has been toward more than five speeds.

With either 8 speeds having approximately 36% steps or 10 speeds with approximately 29% steps,

it is possible to provide good performance under a wide variety of operating conditions. It is also possible to provide excellent flexibility with a five-speed transmission and a torque converter. We have not shown the gradeability curve comparison in this case because the curves are superimposed on each other and are difficult to read. We can say, however, that the curves for either of the mechanical combinations or for the five-speed and torque-converter combination indicate complete coverage of the usual operating requirements.

Comparative acceleration curves for a 10-speed combination and the five-speed converter combination show the good initial acceleration and reduced amount of gear shifting possible with a torque converter. (See Fig. 4.)

### Consider a 60,000-lb Tractor-Tandem-Semitrailer

Several companies, including White, have been exploring the performance of converters in conjunction with five-speed transmissions in heavy-duty, long distance, tractor-trailer operation. Our work has been done with a 60,000-lb gross combination tractor and tandem semitrailer.

The tractor was equipped with a 504 cu in. gasoline engine, Spicer two-stage torque converter with a 3 to 1 stall torque ratio, and a five-speed synchronized transmission. Transmission ratios were direct, 1.33, 1.78, 3.05, and 5.08. The axle ratio was 6.29. The converter was governor controlled to lock out above 2400 rpm and return to converter drive below 1500 rpm. A 14 in. single plate clutch, placed between converter and transmission, was used to interrupt the drive line to permit manual shifting of the synchronized transmission.

The installation was so arranged that test trips of 200 miles could be run alternately with and without the torque converter. With the torque converter locked out, best acceleration was obtained when going progressively up through the five transmission speeds. When the converter was in use, acceleration was best when starting in second gear. It was almost as good when starting in third gear.

The test route was over rolling country and through numerous small towns. It also included about 10 miles of heavy city traffic at each end of the trip. (During the tests, we found that, by using the converter in conjunction with third gear of the transmission, we could operate in city traffic without making any gear shifts.)

### Test Results

Data from these tests were compared with that obtained by two other companies making similar tests. It was found that:

1. The average number of gear shifts per mile was 35 to 55% less on converter units.

2. Fuel consumption varied a maximum of 7%, with the converter proving superior in several of the runs.

3. There was a maximum variation of 3% in average speed on each series of tests. In some cases, the converter unit was faster; in others, the geared unit was faster.

4. Average engine revolutions per mile were consistently less on the converter units, the maximum difference being 12%.

These results were favorable enough to justify further study under actual operating conditions. We have, therefore, arranged to deliver a test tractor to a petroleum hauler for use in a fleet of similar mechanically equipped vehicles.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

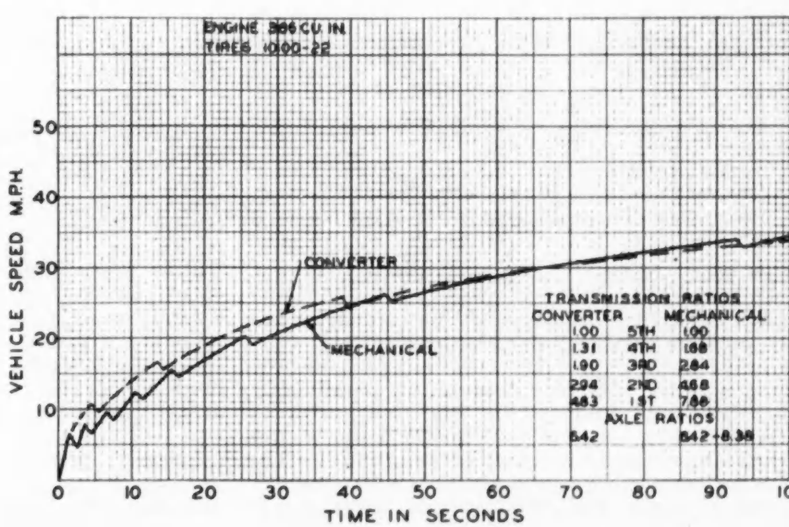



Fig. 4—Acceleration curves for two 50,000 lb gcw tractor-trailer combinations—one equipped with a five-speed mechanical transmission and two-speed rear axle, the other with a torque converter and five-speed transmission. Note the good initial acceleration and reduced amount of gear shifting possible with the torque converter

# What Makes Production

FARMING out aircraft parts and assemblies for manufacture is a dead serious business. A whole production operation can stand or fall on whether subcontractors "deliver the goods." Since overall costs, product quality, and ability to meet manufacturing schedules hinge so much on suppliers, prime contractors have to be darn careful in selecting them. And having made their selections, production procurement departments have to make sure that responsibility is fixed . . . and that things keep running smoothly.

Among the things that have to be considered by a production procurement department are:

- Source development
- Policies and relations with subcontractors
- Maintenance of engineering change control
- Vendor follow-up

### Source Development

One company maintains a group within its purchasing department that handles all outside contacts on procurement matters, including the development of new sources. This group reports directly to the manager of the procurement department. Its personnel has been selected because of their:

1. Engineering, manufacturing or inspection experience.
2. Administrative ability.
3. Overall knowledge of the operation of the firm.
4. Previous business experience or good business acumen.

This group maintains complete files on present suppliers and potential new sources. These files include current data on suppliers' personnel, equipment, relative financial standing, inspection facilities, and catalog data if the supplier produces proprietary items. All new sources are thoroughly investigated and educated by this group prior to receiving orders. All contacts between prime and subcontractor, either internal or external, are coordinated with this group. All contemplated engineering changes and experimental designs are transmitted through this group, thereby providing the procurement section with additional time to effect change-overs or to locate optimum suppliers prior to actual release of change instructions.

A simple but effective method has been adopted by one company to aid salesmen in contacting the proper personnel within its organization. A pictorial chart in this company's reception room indicates commodities purchased by the firm, together with the buyer (and his telephone extension) authorized to procure these items.

In the event that a new source must be developed for a highly specialized item, the following steps might be necessary in locating a source:

1. Check vendor file for a source previously investigated but not currently a supplier . . . and advertised sources as found in Thomas' Register or trade journals.
2. Secure leads from allied buyers.
3. Request processing data and equipment requirements from the internal production engineering department. With this information available, a check with machine suppliers may uncover possible sources which have necessary equipment to produce the required part.
4. In extreme cases, it may be necessary to circularize the entire field on a mass inquiry basis.

Education of suppliers is a prime responsibility of procurement. If successfully accomplished, it will eliminate costly misunderstandings at the time when deliveries commence. (Education problems are not unique to new suppliers. It frequently becomes necessary to re-educate current sources.) Unless prospective vendors are thoroughly educated, trouble can be anticipated when procuring aircraft quality parts from firms producing commercial grade material.

Trouble can also be expected when attempts are made to run experimental material in a plant currently producing a similar type part on a production basis.

Prior to releasing an order, "aircraft quality" must be defined, inspection standards finalized, and responsibilities assigned. This can be done within

# Procurement Click!

**D. C. Fehleisen,** Fairchild Engine Division, Fairchild Engine and Airplane Corp.

Based on secretary's report of Panel on Production Procurement held as part of the Aeronautic Production Forum at the SAE National Aeronautic Meeting, New York, April 20, 1953. Panel Leader was J. Ralph Walker, Fairchild Engine Division, Fairchild Engine and Airplane Corp.

the body of the purchase order, and by the transmittal of supplementary specifications, inspection manuals, and gages. In cases where it is necessary to maintain resident inspectors, engineers or troubleshooters in a vendor's plant or where periodic visits of a plant are required, "over-quality" must be guarded against.

### Policies and Relations with Subcontractors

Different policies exist between firms with respect to furnishing raw material to subcontractors. It is the policy of some companies to furnish material to subcontractors only on close delivery items. Others furnish all raw material to their subcontractors.

Different methods of billing are used, but in all cases material is billed at cost, with no charges imposed by the prime contractor for handling or profit.

The furnishing of material to subcontractors usually presents problems of affixing responsibility in the event that defective material is discovered after parts have been completed. It is extremely important, therefore, that a clear understanding exists between prime and subcontractor on overall responsibilities prior to the release of a purchase order. To prevent any misunderstandings, the prime contractor should make certain that the subcontractor realizes it is his responsibility to inspect all material received by him, regardless of the source of the material. In short, the subcontractor must realize that he is responsible for the end product produced; that future rejections by the prime contractor cannot take into consideration defective raw material.

In cases where it is necessary to use multiple vendors to produce a single product, the problem of responsibility can become quite complex. One firm has solved this problem by assigning the responsibility of assuring the quality of the final product

**Members of the Production Procurement Panel**

**J. Ralph Walker,** Leader
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**J. W. Dunnell**
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United Aircraft Corp.

**E. T. Sturgis, Jr.**
Purchasing Agent
Glenn L. Martin Co.

to the last vendor to perform an operation. (This, of course, makes it necessary for him to inspect previous operations performed by other vendors before he performs his operation on the parts.) Another firm performs interim inspections at its home plant before reshipping material to subsequent vendors for additional processing. Still another solution does not have the disadvantages inherent in the previous plans, but unfortunately it cannot always be used. It involves the elimination of procurement from all vendors except the one performing the last operation. In effect, this vendor becomes a prime contractor who must deal directly with the other supplying sources. Of course, use of any of these plans is dependent on the type of vendors used in procuring the part in question.

Dual sources of supply should be sought on all parts to insure continued production in the event of a shutdown of any one supplier.

In some cases where dual sources of suppliers are maintained, prices are different for the same part. Price differentials may result from variations in processing methods or overhead costs of the different suppliers. Where price differentials exist, the purchasing agent must keep in his records an adequate explanation that justifies the price differentials.

### Maintenance of Engineering Change Control

Engineering change notices can be divided into these two general classifications: (1) mandatory changes which are of an emergency nature, and (2) convenience changes which facilitate manufacture or decrease costs.

With reference to contemplated changes, some firms have adopted a practice of advising the procurement section of all anticipated changes before approval and actual release. This practice enables procurement to take preliminary action on contemplated changes and, in many cases, saves the prime contractor considerable expense in effecting a smooth changeover. However, in no case is the procurement section authorized to take any action on change notice instructions without prior approval from the production control department.

Mandatory changes require special handling to insure rapid execution. In plants where special processing of mandatory changes is authorized, the procurement department is permitted to furnish change instructions verbally to the suppliers. Sufficient curbs must be established, however, to prevent abuse of this method.

### Vendor Follow-Up

To insure smooth operation, the number of personnel dealing with vendors should be kept to an absolute minimum. In firms where buyers do not perform the expediting function, the expeditor should be given a complete background resumé of previous contacts before he makes his initial contact with the supplier. An uninformed expeditor may, in his zeal to maintain a schedule, irritate rather than cement relations with a supplier.

(The report on which this article is based is available in full in multilithographed form together with reports of the nine other panel sessions held at the 1953 SAE Aeronautic Production Forum, New York. This publication, SP-302, can be obtained from SAE Special Publications Department. Price: $2 to members; $4 to nonmembers.)

# Weapons System Approach . . .

**. . . is easy to understand if you compare it to the study a football coach, faced with a radical rules change, might make.**

Based on paper by **Arthur L. Lowell,** McDonnell Aircraft Corp.

TO illustrate what is meant by the new, much-talked-of "weapons system approach," let's suppose you are head football coach at a large university. And let's suppose also that the rules of the game are suddenly changed to limit teams not to 11 players but to 2500 lb of players.

With the rules change, you'll have to restudy all the situations of play, varying the number of players on your side and on the opposing side.

Probably you soon find that football team redesign is taking all of your time. So you take on as helper a young instructor from the mathematics department, a man versed in the theory of probability and the theory of games.

This mathematician expresses the probability of success of various team and tactics combinations by complicated equations. To evaluate the equations, he needs numerical effectiveness ratings for standard players of various weights in performing different operations occurring in team play. So he runs time and motion studies. He also evaluates such things as starting acceleration, momentum, kinetic energy, and maneuverability of various sizes of players.

His computations completed, the mathematician presents you with a pattern for a new, supposedly optimum football team to match the new situation.

By commissioning this study and being guided by its findings, you have adopted the "system approach." Our military experts are now taking the "weapons system approach" to the business of protecting our country. The chief difference between the football analogy and the real case is, of course, that the "rules" change all the time and there are many more "players" to consider. (Paper "Guided Missiles and the Weapon System Concept" was presented at the SAE St. Louis Section, April 14, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

# Ductile Iron Makes Good

THIS relatively new, spheroidal-graphite type of cast iron has already achieved a secure place in the spectrum of engineering materials, despite patent and license uncertainties. It is proving especially useful in a number of applications requiring toughness and wear resistance. Here are some of them:

## Spindles for Grain Drills

Switching to ductile iron cut costs of spindles for grain drill disc openers considerably for National Farm Machinery Cooperative.

Originally the Co-op had made the casting in ordinary white cast iron and chilled the wear points to insure durability. Chill maintenance was a constant source of trouble, and faulty chilling sent many parts to the scrap bin.

Then the Co-op tried ductile iron. The foundry found that by casting a pipe bushing into the body for a grease fitting they could cast a completely satisfactory spindle from white magnesium-containing iron. Strength and shock resistance were adequate. Scrap losses diminished. And overall costs dropped.

## Runners for Corn Planters

Ductile iron successfuly replaced forged and welded steel runners for National Farm Machinery Cooperative's corn planters, before the Co-op went out of business.

Body of the cast runner was 1/4-in. thick. Its cutting edge was about 1/16-in. thick. That way, the body had sufficient toughness, yet the carbides formed in the thin edge resisted wear.

Field tests showed that the cast runner was better than the old type. Just as important, cost figures showed that it was a lot cheaper to cast the runner than to make it the old way—which was to forge it out of SAE 1045 carbon steel, weld it, rivet into place the cast runner block, straighten the assembly, heat-treat it, and grind it.

## Crankshafts for a Press

Ductile iron has served satisfactorily for the crankshaft of the large press in which the ductile iron heading dies shown on page 47 are used.

State Foundry and Machine Co. made the first cast ductile iron crankshaft for the press when its owner couldn't get delivery of the regular forged SAE 4150 steel replacement crankshafts soon enough to keep shell production going.

The fully annealed cast crankshaft lasted longer

**The accompanying article is based on the papers:**

**Nodular Iron in Tractor Motors**

**by H. L. Day**

Auto Specialties Mfg. Co., Inc.

**Irons with Spheroidal Graphite**

**by R. W. Mason, Jr.**

Engineering Castings Inc. and formerly with National Farm Machinery Cooperative, Inc.

**Ductile Iron as an Engineering Material**

**by B. L. Stott**

State Foundry & Machine Co.

**These papers were presented at a symposium on ductile iron at the SAE Annual Meeting, Detroit, Jan. 13, 1953.**

**The complete papers are available in multilithographed form from SAE Special Publications Department at 25¢ each paper to SAE members and 50¢ to nonmembers.**

than the usual steel shafts, probably because of the improved damping capacity due to the presence of free graphite. So the first order for one cast crankshaft has led to an order for three more like it.

## Liners for Concrete Pumps

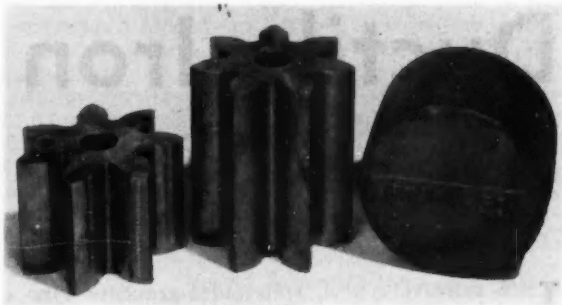
In a test of liners used in a pump raising concrete vertically through a pipe, a ductile iron liner ran twice as long as a steel liner. This is an indication of ductile iron's resistance to abrasive wear.

The ductile was cast, machined, and then oil quenched from 1650 F to a hardness of Rc 58. The steel liner was torch cut from plate, rolled up, welded, bored, and hardened.

Ductile iron proved itself a superior engineering material in this case. But steel liners are cheaper. The manufacturer still makes steel liners because he does not feel the performance of ductile iron justifies the extra cost.

## Pump Rotors

These priming rotors for a fire truck high pressure pump are cut from solid ductile iron blanks. The blanks are heated to 1300 F for 5 hr. They have a

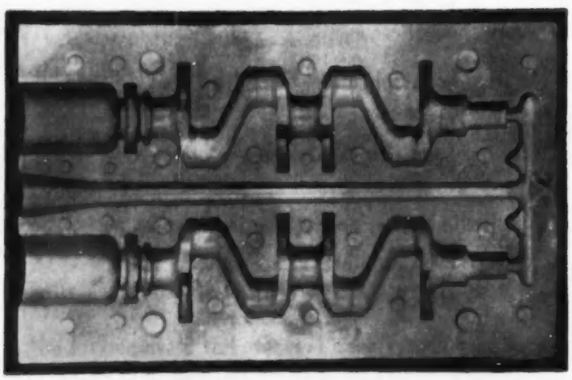


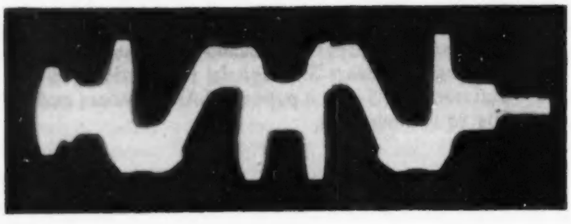
hardness of 170 Bhn. Physical properties are good, and machinability is excellent, according to State Foundry, the producer.

## Crankshafts for Tractor Engines

For crankshafts, ductile iron has advantages over other materials, Auto Specialties Mfg. Co. found. Ductile iron's better castability results in sounder castings and closer size fidelity.

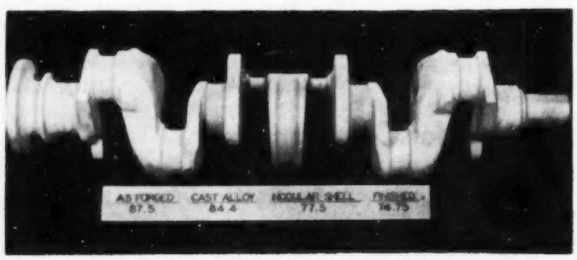
Besides, ductile iron cast in shell molds gives a better casting yield than steel or cast alloy does. The sprues and feeders can be small, as the photograph of the mold shows, yet do a good job, as the 1,000,000-v X-ray radiograph proves.

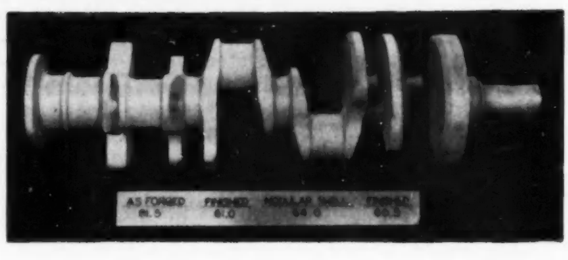




The photographs comparing ductile iron crankshafts cast in shell molds show the magnitude of the savings in metal. As much as 17.5 lb can be eliminated, and along with it the costly machining otherwise required to remove this metal. More recent information indicates that it is possible to core out the crank pins of the V-8 crankshaft so that only 0.75 lb need be machined off to finish it.

Ductile iron crankshafts exhibit favorable damping characteristics because of their lower modulus of elasticity.



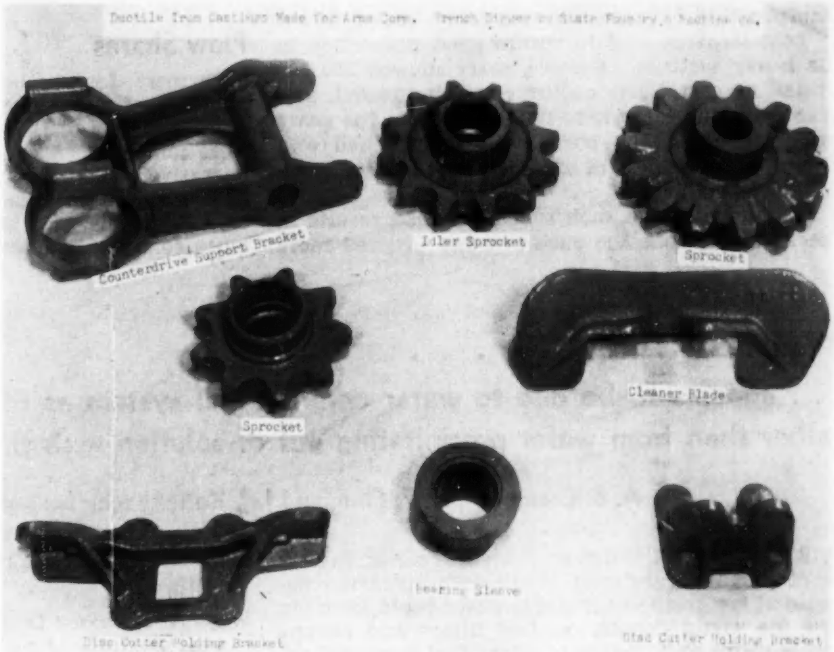



## Sprockets for a Trenching Machine

State Foundry is very proud of the ductile iron sprockets it makes along with other parts for a trenching machine.

Before switching to ductile iron, the foundry had tried many materials and found them wanting. Materials treated for maximum wear broke. Materials that were tough enough so that they didn't break wore.

But with ductile iron, the shop heat-treats the sprockets differentially, obtaining teeth that have hardness close to Rc 60 along with hubs that are machinable. Now the chains wear out faster than the sprockets, and the sprockets don't break either.



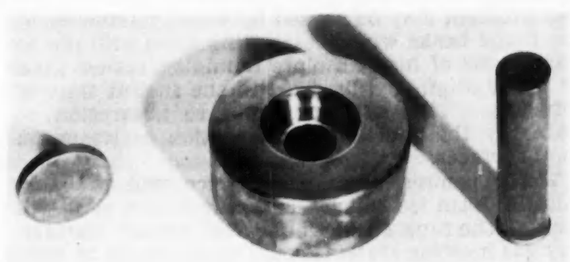

## Sprockets for Farm Machinery

Ductile iron has replaced gray iron as the material for this light-section sprocket to cut down on failures from wear and breakage. State Foundry makes the part.

In ductile iron it contains some carbides as cast, which promote wear resistance. For this reason, the heat-treatment consists only of a draw at 1300 F to increase toughness without destroying the carbides.

## Heading Dies

Heading dies for a 20-mm shell when made of ductile iron instead of tool steel lasted more than 10 times as long and cost half as much as when made of tool steels. In ductile iron, die life is about 875,000 shells; in tool steel, it's 45,000–60,000 shells.



## Main Drive Pinion on Drag Line

Ductile iron replaced manganese steel castings and heat-treated SAE 4340 forgings for the main drive pinion on a large drag line. The ductile iron pinion was installed, with an SAE 4640 steel driven gear that was already pitted, on the machine that gave the most trouble with breakage in the field. After two weeks of operation the pitting disappeared from the driven gear, and both gears were in excellent condition. After two years, the drive pinion

was still in operation.

This amazing pinion was made of ductile iron incorporating between 2.75 and 3.00% nickel to aid in heat-treating and to secure good properties in the heavy sections. Sample gears showed 250-300 Brinell as cast. The castings were annealed, and gear teeth and faces were finished. Then the gears were packed in the bore, heated, quenched and drawn to a hardness of 425-450 Brinell, then finish bored and splined.

This process gave such sustained good results in the field test that the customer has ordered more of these ductile iron pinions from the producer, State Foundry & Machine Co.

## Plow Shares

Farmers found that plowshares made experimentally of ductile iron didn't break and wore just as well as any of the steel shares with which they were compared. The National Farm Machinery Cooperative, which cast the plowshares, found it difficult at first to make sound castings. But after trying various gate and riser arrangements, they quite consistently produced clean, sound shares.

# Fuel Filter Ice . . .

**. . . appears to be due to water entering fuel system as condensate on fuel tanks rather than from water precipitating out of solution with the fuel.**

Digest of paper by **A. B. Crampton, H. F. Finn, and J. J. Kolfenbach,** Esso Laboratories, Standard Oil Development Co.

DISSOLVED water and entrained water in fuels is of particular interest in aircraft operation because at low temperatures this water could form ice. The ice would deposit on fuel filters and control mechanisms and adversely affect fuel flow and engine performance. Long-range, high-altitude flights will aggravate the problem, and the use of micronic filters in fuel lines will maximize the danger of plugging from any ice present.

Studies indicate that filter icing from dissolved water precipitating from a warm fuel on cooling may not be the problem originally envisioned. With good venting, water should have a chance to escape before the fuel temperature is low enough to cause freezing. When tanks are adequately vented, the real problem may be caused by water condensed in the plane tanks when descending from altitude to warmer air of high absolute humidity, rather than by water originally dissolved in the fuel at time of refueling. This situation leads to absorption of water by the fuel and condensation of water on tank surfaces.

Water coming from this source will probably initially form ice which could plug filters, or it will melt as the tank surfaces and fuel become warmer. Dry gas inerting systems could undoubtedly be used to advantage in overcoming the initial condensation problem. Water will also condense in cold fuel tanks while the plane is on the ground. On subsequent refueling this could result in entrained water of sufficient amount to have obvious adverse effect. Consequently, the water should be removed before refueling, or the condensation prevented by some type of vent closure.

The potential seriousness of the problem is such that the conclusions reached through studies with laboratory scale equipment should be checked in actual aircraft. (Paper "What Happens to the Dissolved Water in Aviation Fuels" was presented at SAE Summer Meeting, Atlantic City, June 11, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

### Based on Discussion

**By Allan Eaffy,**
Wright Air Development Center

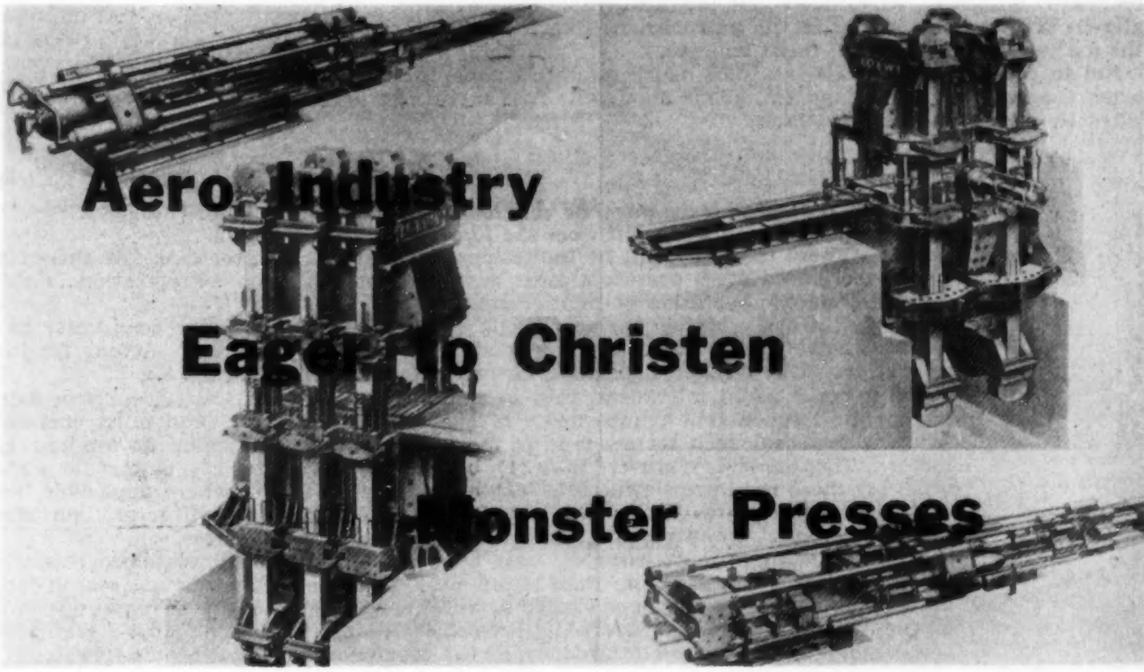
The handling of fuel in the trailers is one of the most important steps in eliminating water from fuel. Trailers should be filled at the end of each day, allowed to soak and then drained of condensate. When full there is a minimum surface vent area exposed and less chance for condensation to occur. The segregator should be drained again in the morning.

Similar precautions should be taken in handling aircraft. They should be serviced after each flight, particularly the last flight of the day. After 15 to 30 min the tank should be opened and drained of condensate. Special care should be taken in filling, soaking, and draining, when a plane has been taken from a warm hanger to a cold atmosphere for refueling.

**By R. R. Higginbotham,**
Republic Aviation Corp.

The necessity for filter de-icing should be promptly and definitely established, or else the heavy, bulky, expensive alcohol de-icing systems should be discarded. If established, filter de-icing should be accomplished by the waste heat of the engine.

Unfortunately, tests have been inconclusive, but there is evidence that dissolved water alone would not constitute an icing hazard where there is a suitable ratio of filter surface area to fuel tank capacity. If true, icing can be avoided by proper ground servicing equipment. Further reduction of water content could be achieved by venting storage tanks, other than water displacement tanks, and particularly servicing trucks, to the atmosphere through a dessicant chamber. This would be in line with the encouraging trend toward conditioning the fuel on the ground instead of carrying a refinery in the plane.



# Aero Industry Eager to Christen Monster Presses

**J. R. Douslin,** Wyman-Gordon Co.

Based on secretary's report of Panel on Large Forgings and Castings held as part of the SAE Aeronautic Production Forum at the SAE National Aeronautic Meeting, New York, April 20, 1953. Panel Leader was G. W. Motherwell, Wyman-Gordon Co.

***Question: When will the large presses being installed under the U. S. Air Force program swing into action?***

Answer: Several forging presses imported from Germany after World War II already are operating. (They range in capacity up to 16,500 tons.) It is reported that one German extrusion press of 14,000-ton capacity will be in operation this year.

The first of the new forging presses (there are a total of eight under construction, ranging in size from 25,000 to 50,000 tons) is expected to be in operation the second quarter of 1954. The others are expected to follow in close succession.

***Question: Is overemphasis being placed on the use of large light metal forgings in aircraft?***

Answer: No. In fact, many people close to the problem believe that even greater emphasis is needed. Why? It's because design and manufacturing problems encountered in building modern aircraft have multiplied many times since World War II. More and more performance has had to be built into less and less space. This has called for new design thinking and new manufacturing techniques.

Large forgings with high strength/weight ratios make possible designs not otherwise considered producible. At the same time, they offer large savings in assembly and machining man-hours . . . and in material.

There are many who believe that liberal use of large forgings would be the only practical way to mass produce modern aircraft in an emergency.

***Question: Are aircraft designers thinking in terms of large forgings and extrusions?***

Answer: Yes. A recent survey of 18 aircraft companies on the West Coast and in the

Southwest indicated widespread and practical interest, as evidenced by designs actually on drafting boards and in the procurement stage. Similar interest is reported on the part of Midwest and East Coast builders.

Not to be overlooked is the fact that many aircraft companies are and have been using the largest forgings and extrusions obtainable . . . and expect to use larger ones when the new presses are available.

***Question: Will aircraft designers be able to get the kind of product they need and want from the large presses?***

Answer: There obviously will be limitations on what can be produced. At this stage even experienced press operators must base their estimates on extrapolation of data secured from the operation of smaller presses.

As regards size, forging operators believe that forgings of average complexity having 3000 sq in. projected area can be made on a 50,000-ton press. Actual forgings may be larger or smaller, depending on relative difficulty of forging.

Closer dimensional tolerances, thinner webs, and smaller draft angles must be listed among the more urgent requirements of the aircraft designer. And press operators face the fact that such factors tend to move in the wrong direction as forgings get larger. They believe, however, that (1) better die lubricants, (2) better die materials, (3) more rigid press structures, (4) use of die quenching where applicable, and (5) other improved manufacturing techniques already well along will more than offset the size factor . . . and result in larger forgings to closer tolerances.

Aircraft designers must think at least five years ahead. To stimulate progress, they must continually ask for more than is presently available. This constant search for a better product should not be construed as reluctance to go along with press operators as they strive to solve manufacturing problems. However, it does dictate an ever closer cooperation between user and producer if the maximum potential of the new tools is to be realized.

***Question: How will the rigidity of the new forging presses affect forging tolerances?***

Answer: Increased press rigidity will result in better die closure. This will permit better control of forging thickness and minimize thickness variation from edge to center of forging.

Such improvement will be particularly helpful in assisting development of integrally-stiffened, thin-skinned wing panels and other similar parts.

## Members of the Large Forgings and Castings Panel

**G. W. Motherwell,** Leader
Vice-President, Charge of Manufacturing,
Worcester Division
Wyman-Gordon Co.

**J. R. Douslin,** Secretary
Superintendent, Grafton Plant
Wyman-Gordon Co.

**Alexander Zeitlin**
Vice-President
Loewy Construction Co.

**W. C. Shulte**
Chief Metallurgist, Curtiss Propeller Division
Curtiss-Wright Corp.

**Frank Herlihy**
Assistant Chief Metallurgist
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**W. A. Dean**
Chief Metallurgist, Cleveland Works
Aluminum Company of America

**G. D. Welty**
Product Manager, Forging Division
Aluminum Company of America

**Gerhard Ansel**
Technical Director, Madison Division
Dow Chemical Co.

**Paul P. Zeigler**
Director of Metallurgical Research Division
Kaiser Aluminum & Chemical Corp.

***Question: Can an aircraft manufacturer afford the cost of forging dies if only a few pieces are needed?***

Answer: In many cases, dies can be amortized economically with as few as 15 to 20 sets of forgings. Where prototype forgings are required in quantities of only 4 to 6 pieces, limited (less costly) tooling will frequently suffice to produce a "blocker-type" forging suitable for the first few pieces.

One forging vendor reports promising results using cast Kirksite dies reinforced with steel for producing small quantities of blocker-type forgings. This method, if successful, promises even lower tooling costs for prototype quantities.

***Question: Will use of higher die temperatures during forging improve producibility of large light metal parts?***

Answer: Die temperatures of at least 500 F are considered essential. For many thin-sectioned jobs, die temperatures as close as possible to stock temperatures are desirable. At present, a practical top limit appears to be in the neighborhood of 800 F. Above this, adequate die lubrication is difficult and strength of standard die materials begins to be affected.

Die heating must be done with care to avoid damage to the dies. For best results, temperature of the die should be uniform and maintained at the desired level during forging.

***Question: What is being done about getting orders on the books for parts to be produced by the large presses?***

Answer: Press operators are leaving no stone unturned in working with designers and builders to promote the development of large forging and extrusion applications.

The USAF, too, is doing its part in urging builders to utilize the new tools. Practical evidence of this is the report that the USAF is prepared to authorize duplicate procurement of suitable items, thereby assuring that plane production schedules would be met by the use of built-up structures should unforseen difficulties arise in using the large integral parts.

***Question: Will cast steel dies be used for the large presses?***

Answer: There should be a place for them if they can be produced with enough strength and ductility, in large enough sizes, and to close enough tolerances. The biggest block produced by one foundry (to a tolerance of 0.002 in./in.) weighed 8000 lb. Press operators feel that available sizes must be much greater than this 8000-lb block if they are to be useful for the large press forgings.

***Question: In spite of what has just been said, we understand that very few, if any, actual orders are now on the books for large forgings or extrusions from the new presses. Tooling-up time is reported to be 9 to 12 months. If the first press is to be in operation the second quarter of 1954, shouldn't orders be on the books now?***

Answer: From the standpoint of the press operators, the answer is very definitely in the affirmative. Some of the reasons for hesitancy in placing orders have been indicated previously. Other reasons are frequently groundless or based on misconceptions. For instance, the fear that large enough die blocks or adequate die sinking capacity will not be available is discounted by most operators. Provisions for interchangeability of dies for operation on one press or another in case of unexpected press or die failure have been provided for.

***Question: Will raw material of adequate quality and size be available?***

Answer: Aircraft builders are looking for something better than has been available in the past. Whether or not they get it will have a bearing on how many large parts

are designed. All major producers of rod and bar are working on the problem and some notable success has already been achieved.

***Question: These presses will have a tremendous capacity to produce forgings and extrusions. Will there be enough raw material available?***
Answer: Magnesium producing capacity appears adequate. Aluminum producing capacity is being rapidly expanded. The current scarcity of forging quality rod and bar is temporary.

***Question: Assuming sufficient pig is available, what about facilities for converting it to ingots and shapes? Is there enough emphasis on this part of the program?***
Answer: There are two main aspects to this problem: (1) the making of sound ingots, (2) transformation into shapes of maximum quality by the proper type and amount of work.

One producer claims much progress in producing ingot up to 30 in. diameter that is virtually free of gas and porosity. A USAF contract is being procured to cover development of ways to reduce such ingot to desired shapes and sizes with highest quality. Methods to be studied include upsetting, cross working, cogging, drawing, rolling and extruding. It is expected this work will be complete by the time the new presses are ready. Meanwhile the facilities for making ingot are being converted to the new process.

Another producer has been working on the problem for a number of years. This company reports that it can now produce sound ingots in 14S and 75S up to 6000 lb; that it has produced ingots up to 9000 lb experimentally; that larger ingots are in the works.

***Question: What are the factors that affect soundness of ingot?***
Answer: There is more than one source of unsoundness. Shrinkage, $H_2$ solubility, and fluxing practice must be considered.

***Question: What effect does the type of melting equipmet currently in use have on ingot soundness? Aren't electrically heated furnaces better?***
Answer: The basic problem is one of properly cleaning and degassing the melt . . . and keeping it that way. One method used is to degas and clean the melt after it has been poured into an electrically heated ladle. Another way involves use of an auxiliary chamber into which the metal is drawn for cleaning and degassing before pouring.

Electrically heated furnaces may simplify the job of obtaining and maintaining a good melt, but if the same results can be obtained with present equipment by other methods this should be the answer.

***Question: Why isn't more use made of blanks cast to rough shape, then finish-forged to final shape?***
Answer: This has been and can be done. It is a question of economics and quality. Present indications are that forgings made in this way will not be as strong or ductile as those forged from bar.

***Question: Most of this discussion has been about light metal forgings and extrusions. What about steel?***
Answer: One of the new extrusion presses is being built expressly for steel.

There is a need for hollow extruded steel landing gear. The extrusion presses and large forging presses with side cylinders are expected to make possible hollow formed shapes in steel, with or without attached bosses, tapered sections, and so forth.

## Castings

***Question: What difficulties are experienced in casting steel of the 25-12 type with 3% tungsten?***
Answer: Soundness and porosity do not present too much of a problem. There is an end effect in which the grains solidify in a direction perpendicular to the mold wall. In many applications this has not been found harmful to performance. The material is susceptible to tearing. This presents a problem where fins must be cast.

***Question: What can be done to reduce the variation in quality of aluminum castings? In a recent test case, a 220 alloy casting was ordered from several sources and results were all over the lot.***
Answer: Good aluminum castings of consistent quality can and are being made, but to secure such parts certain common-sense rules must be observed.

First, engineering people at the customer's plant and at the foundry should get together and determine what is the best design and what is the proper alloy.

Second, do not ask purchasing to order any casting from any foundry.

***Question: Why is it that castings sometimes have lower properties than test bars or a properly cast ingot?***
Answer: Test bars and ingots can be cast under conditions that approach the ideal. On the other hand, a shape may have many difficult configurations, changes in section, thin walls, and so forth, all of which call for higher skill to produce a sound part. However, a reputable foundry will make sure that (1) design and alloy selection are proper, and (2) methods are used which will produce a part in which the relationship between test bar and casting is consistent and dependable.

***Question: What is the size limitation on magnesium castings?***
Answer: Naturally, it depends on the part and the casting method employed. A 400 lb undercarriage being used in England is about 7 ft long and has an average section of 1 in. Many castings are mass-produced today in the 100 to 150 lb range. The largest casting which comes to mind is a 1600 lb base for a radar station.

***Question: What are the minimum wall thicknesses which can be obtained? Is it possible to get as low as 0.090 in.?***
Answer: It is reported that a California concern is having some success in this range. A 2-ft square magnesium panel has been cast with walls averaging 0.080 in.

High density alloys have not yet been successfully cast with $\frac{1}{8}$ in. walls using normal

practices. Using the frozen mercury process, however, 14 in. diameter rings with 1/8 in. walls have been successfully made as have 20 in. diameter rings with walls only slightly over 1/8 in. In SAE 4140 and types 310 and 410 stainless, such rings can be made up to 36 in. in diameter.

***Question: What about tolerances on these ring castings?***
Answer: The higher the casting temperature required the more difficult it is to hold tolerances. It is not just a matter of shrinkage. It is also a question of finding mold materials and binders which will withstand the high temperatures.

One foundry makes thin-walled rings up to 2 ft in diameter with a tolerance of ±1/16 in. Another foundry is making 36 in. diameter rings to ±0.030 in., but in this case wall thickness is greater, there being 1/2 in. excess material allowed on the ID.

Using the frozen mercury or the plastic process, very close tolerances and thin walls are possible, although at present the size of such castings is limited.

***Question: How are some of these limitations in wall thickness and tolerances being overcome?***
Answer: In many cases, by machining. One promising method involves casting, followed by rolling to thinner walls and to shape.

***Question: Are there any programs underway in the casting field, comparable to the large press program in the forging field, aimed at improving the present limitations on size, wall thickness, tolerances, and so forth?***
Answer: Probably not anything that could be called comparable. Nevertheless, there is much work underway all over the country to develop new and better methods. The frozen mercury and shell-molding processes, for instance, are in their infancy . . . and hold much promise for further development.

***Question: Is it considered permissible to weld aluminum and magnesium castings for aircraft use?***
Answer: Welding is permissible in low stressed areas, using the heliarc process.

***Question: Can light alloy castings be successfully impregnated?***
Answer: High vacuum impregnation is done using silicates or synthetic resins. In many applications, synthetic resins are preferred because they are more resistant to aircraft oils.

***Question: Where do castings find their most important field in aircraft?***
Answer: At present, in aircraft engines. These are high grade aircraft quality parts. There is developing a tremendous field for so-called "B" grade castings in the field of limited service, one shot use, such as occurs in guided missile service.

(The report on which this article is based is available in full in multilithographed form together with reports of the nine other panel sessions held at the 1953 SAE Aeronautic Production Forum. This publication, SP-302, can be obtained from SAE Special Publications Department. Price: $2 to members; $4 to nonmembers.)

# Easier-to-Live-with Trucks Target of West Coast Meeting

by J. B. Tompkins, Editor, Westrade Publications

TAKING a tip from the railroad-minded tunesmith of old, engineers at the International West Coast Meeting, Vancouver, B. C., Aug. 17–19, beat out a lively tune of their own entitled, "We've Been Workin' on Trucks All the Live Long Day." And just like the railroaders of yesteryear, they added chorus after chorus to their ditty, chronicling what they've done to improve trucks and truck operation . . . and what still remains to be done.

Equally thought-provoking and well received were the banquet speeches SAE President Robert Cass and the Reverend William Hills delivered to the more than 325 people jammed into the Hotel Georgia's ballroom.

Prexy Cass, highlighting the international theme of this first of two SAE international meetings north of the 49th Parallel this year, estimated that Russia will graduate 30,000 engineers this year, the U. S. and Canada only 19,000. And we're just kidding ourselves when we go around saying their en-

## They Played Important Roles

Outstanding success of this first of two international meetings north of the 49th Parallel this year was due in no small part to this quintet: (left to right) Reverend William Hills, Banquet Guest Speaker; H. L. Hinchcliffe, Banquet Toastmaster; Alan B. Reid, B. C. Section Chairman; Robert Cass, SAE President; Harold Puxon, General Chairman, International West Coast Meeting

gineers are not as capable as ours, he warned. We on this continent are going to have to do more to encourage interest in engineering.

Rev. Hills, too, hit on the worldly theme of the meeting as he outlined his "Third Dimension for the World." Reminding his audience that our world today has no more geographic secrets, the World War II naval chaplain cautioned engineers not to fall into the position of obliteration of the spirit.

The dimension of space and distance, a revolution in the conquest of geography, was listed by Rev. Hills as the "first" dimension; the technological age, the "second." But, he pleaded, never let man be incapacitated by reason of the machine! Despite the vast engineering knowledge represented by SAE, engineers have no control over the human being and the "third" dimension—the human soul.

Goaded on by the huge turnouts at each of the six technical sessions, one engineer after another related what each has learned from workin' on trucks. Reported were:

*Ways trucks have been improved:*

- Exhaust gas turbosupercharging has made it possible to boost output of high-speed automotive British diesels.

- New, simple, inexpensive field-treating processes make raw fuels suitable for truck engines.

- New designs and materials make truck tires far less likely to suffer premature failures.

*Ways trucks still need to be improved:*

- Transmissions that deliver more power to the road without overburdening the driver.

- Brakes that are lighter and more efficient.

- Electrical systems that supply adequate current when a truck engine is idling.

British diesel-engine designers, it was reported, realize that it takes a pretty different breed of animal to power trucks on the North American continent. More power output and greater speed ranges are musts. Exhaust gas turbosupercharging, they have found, is one way to get these characteristics without unduly lowering the thermal efficiencies of their creations.

But diesel or gasoline, raw fuels don't have to give engines acid indigestion, another engineer had learned. The acids in these fuels which cause engine wear can be removed by using new, simple, inexpensive field-treating processes. Admittedly, these filtering procedures won't remove *all* the solid and liquid contaminants and sour constituents (dissolved sulfur compounds) from raw fuels, but they will extract the troublesome portions.

**Committee Chairmen** who fashioned this highly successful meeting:

**Harold Puxon**
General Chairman

**J. S. McLean**
Arrangements

**A. B. Reid**
Banquet

**E. A. Collins**
Finance

**H. D. MacDonald**
House

**J. B. Tompkins**
Publicity

**Burdette Trout**
Housing

**W. D. Stewart**
Registration and Reception

**F. B. Sleigh**
Sight-Seeing and Transportation

**Session Chairmen** who kept things operating smoothly at the six technical sessions:

**A. P. Nelsen**
Monday morning

**B. T. Anderson**
Monday afternoon

**J. E. Glidewell**
Tuesday morning

**W. C. Heath**
Tuesday afternoon

**C. A. Dillinger**
Wednesday morning

**D. F. Hume**
Wednesday afternoon

**Session Secretaries** who did a bang-up job of recording discussion:

**L. W. Garvin**
Monday morning

**R. D. Jolly**
Monday afternoon

**L. B. McPherson**
Tuesday morning

**L. F. Bonar**
Tuesday afternoon

**Clifford Leon**
Wednesday morning

**A. M. Lovick**
Wednesday afternoon

Truck-conscious tire men, too, were able to give an encouraging report: Thanks to new designs and materials, truck tires today seldom suffer the premature failures that were so common 10 years ago. It was explained that:

*Tread cracks* have been practically eliminated by controlling the "growth" of tires in service.

*Tread and ply separation* has been overcome with new types of rubber compounds and cord adhesive dips.

*Heat failures* have been almost eliminated by the universal use of rayon (which is up to 41% stronger at high temperatures and 25 deg cooler running).

*Flex breaks* have been overcome with cords which have better fatigue . . . and with cord dips which provide far greater adhesion of the surrounding rubber to the cord.

It is unlikely, however, that all growth in truck tires can be eliminated, one discusser stated. And until it is, tension caused thereby will promote groove cracking.

This tire engineer suggested heat treatment as one way to combat groove cracking. Annealing will force the sidewalls of a tire together, thus putting the bottoms of the grooves under considerable tension. The bottoms of the grooves are then subjected to temperatures well above the vulcanizing temperature of rubber. When the heated surface is cooled, and the tire returns to its normal shape, the groove bottoms are under compression, he explained. Thus, when a tire is inflated and "grows" in service, groove bottom tension is less than normal, and in many cases, is nonexistent.

To another engineer—a fleet operator who really has to "live" with trucks—it's high time gear jamming of truck transmissions was abolished. Shifting today's truck transmissions is a rough and noisy job at best, he said, and one which usually leads to "hitchhiking" and quarrels with mechanics. But what can a truck driver do when the transmissions supplied him do not provide proper steps and fast, simple shifting patterns?

What's needed, according to this fleet owner, is some real testing of truck equipment to find out what combinations will deliver the most horsepower to the road without overtaxing the driver.

Transmissions aren't the only truck components, however, that were said to be in need of improvement. Brakes and electrical systems came in for strong mention too.

With the trend toward faster, lighter trucks that can carry more payload, truck builders and owners want brake manufacturers to provide brakes that are not only lighter but also more efficient. To brake designers this is a challenge, one which they have gladly accepted.

Just as brakes are being overworked by today's commercial vehicles, so are electrical systems. One way to counter the mounting loads on truck electrical systems is to use rectified a-c systems, according to one electrical engineer. Alternator systems can not only deliver adequate current even when an engine is idling, but they also are lighter than d-c generating systems, he maintained. Only trouble is they cost about 50% more. However, this initial cost difference will decrease as production rates increase.

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(Summaries and highlights of the papers presented at the Meeting are below and on the following pages.)

## Logging Vehicle Maintenance

**J. C. O'Brien, MacMillan Bloedel, Ltd.,** *Problems in Off-Highway Automotive Machinery Maintenance as Applied to Logging in British Columbia:*

No maintenance program for off-highway logging vehicles can be operated at low cost without:

- Proper physical facilities.
- Good maintenance supervisors.
- Driver and operator confidence in the maintenance department . . . and cooperation with it.
- A clear understanding of maintenance problems by top management.

## Preventive Maintenance

**R. C. Keast, Hayes Mfg. Co., Ltd.,** *Preventive Maintenance of Off-Highway Vehicles:*

Sound preventive maintenance of off-highway vehicles can really pay off in a big way. Some operators, in fact, claim they have been able to slash their maintenance costs by 50% with adequate preventive maintenance programs. What's more, they report that employee-management relations were improved almost 100%.

## Two-Cycle Engine Woes

**F. Davison, Industrial Engineering, Ltd.,** *Small Two-Cycle Combustion and Lubrication Problems:*

The high-output, two-cycle engine being used to drive a power chain saw seems destined to remain particularly sensitive to fuels and lubricants. That's because it just doesn't seem possible to bring internal surface temperatures down below a certain point.

## Tire Tidings

**J. J. Robson, Firestone Tire and Rubber Co.,** *What's New in Tires:*

Tire men knew it was their job to supply 100-mph tires for today's 100-mph production cars. And they've done it! But passenger-car tires aren't the only ones that have been improved. Thanks to new designs and mate-

rials, truck tires today seldom suffer the premature failures (tread cracks, ply separations, heat failures, flex breaks) that were so common 10 years ago. As for tomorrow, we can expect to see tubeless tires come into their own in both the passenger-car and commercial vehicle fields.

## Engine Acid Indigestion

**W. G. Nostrand, Winslow Engineering Co.,** *Your Engine Can Be Cured of Acid Indigestion:*

Raw fuels don't have to give engines acid indigestion! These economy fuels can be made palatable. It's just a matter of using new, simple, inexpensive field treating processes. These new filtering procedures won't remove *all* the solid and liquid contaminants and sour constituents (dissolved sulfur compounds) from raw fuels, but they will extract the troublesome portions.

## Mighty Mite Brakes

**J. Douglas Bennett, Fawick Brake Div., Federal Fawick Corp.,** *Post World War II Development in Heavy-Duty Vehicle Brakes:*

A boy may not be able to do a man's job, but truck builders and owners aren't willing to admit that this principle applies to vehicle brakes. With the trend toward faster, lighter trucks that can carry more payload, they'd like brake manufacturers to provide brakes that are not only lighter but more efficient. And right now brake designers are hard at it!

## More Diesels Abroad!

**A. W. Gosling, F. Perkins, Ltd.,** *The Small Automotive Diesel Engine in Great Britain and Europe:*

Small automotive diesel engines are fast gaining popularity in Great Britain today—thanks to their ability to squeeze more miles out of every drop of Britain's high-priced fuels. Not only are more and more new trucks between 5600 and 6700 lb unladen weight getting diesels, an ever-increasing number of gasoline-driven vehicles are also being converted to diesel power. What's more, watercooled, inline, 4-cycle engines with swirl-type combustion chambers are going to find their way into small trucks and passenger cars in the next few years.

## British Diesel Power Up

**S. Markland and J. McHugh, Leyland Motors, Ltd.,** *Some Recent Notes on the Leyland Development of High-Speed Compression-Ignition Engines:*

British diesel engine designers realize that it takes a pretty different breed of animal to power trucks on the North American continent. More power output and a greater speed range are musts. British designers are working out ways to get these characteristics without unduly lowering the high thermal efficiency of their creations. One means they have used to accomplish this is the use of exhaust gas turbosupercharging.

## Why A-C Systems

**Albert D. Gilchrist, Leece-Neville Co.,** *Why Alternator Systems?:*

Mounting electrical loads on today's motor vehicles are causing designers to seriously consider using rectified a-c electrical systems . . . and for good reason. Alternator systems are not only lighter than d-c generating systems, but they can also deliver adequate current when an engine is idling. Only trouble is they cost about 50% more than d-c systems, but this initial cost difference will decrease as production rates increase.

## Servicing Radiators

**Fred M. Young, Young Radiator Co.,** *Radiators for Power Units and Heavy-Duty Vehicles:*

To obtain maximum performance from a well designed cooling system, it should be flushed out every six months, or 25,000 miles, and refilled with water containing a corrosion inhibitor. It's also important to keep the outside surface of cooling components clean. Bugs, dirt, lint, and grease can seriously reduce heat transfer capacity.

## Subzero Fuels & Lubes

**J. A. Miller, California Research Corp.,** *Fuels and Lubricants Solve Cold Weather Driving Problems:*

Special fuels, lubricants, starting aids, and winterization procedures have made possible the starting of gasoline and diesel engines at temperatures as low as −65 F. It's true that new problems are constantly arising as more severe winter operation is experienced, but petroleum company researchers are finding ways to lick them.

## 1960 Truck Engines

**E. C. Paige and H. T. Mueller, Ethyl Corp.,** *The Three E's of Operation and Maintenance—Engineering, Equipment, and Education:*

Powerplants for 1960 trucks will have greater specific outputs, use

less fuel per bhp, and have durability equal to or better than that of today's best designs. It is probable they will have:

- ½ bhp per cu in. of displacement for gasoline engines and 0.4 bhp per cu in. for diesels.
- Compression ratios of 7.5 or higher (gasoline engines).
- Up to 20% better fuel economy (diesels).
- Lower weight—both on a lb/hp and total weight basis. (Diesels will be available weighing only 5 to 7 lb hp).

## Cut Fleet Costs

**Howard Willett, Jr., Willett Co.,** *How Long Should You Run a Truck To Get the Lowest Combined Depreciation and Maintenance Cost?:*

After the first year or two, it doesn't make much difference from the standpoint of operating costs when fleet vehicles are replaced. Knowing this, fleet operators can set up replacement schedules in advance . . . and save money at least two ways by:

1. Not making heavy repairs on vehicles that will soon come out of service.
2. Buying and selling equipment only at advantageous times.

## Abolish Gear Jamming!

**Julius Gaussoin, Silver Eagle Co.,** *Gear Jammers—"Three Hands Cowboy":*

Gear jamming is a pretty rough and noisy job—one which usually leads to hitchhiking and quarrels with mechanics. But what can a truck driver do when the transmissions supplied him do not provide proper steps and fast, simple shifting patterns?

What's needed is some real testing of truck equipment to find out what combinations will deliver the most horsepower to the road without overtaxing the driver.

## Banquet Nuggets

**Robert Cass**
**SAE President**

The "living-room-on-wheels" being turned out by Detroit today—weighing 3000 lb and powered by 125 horses—isn't meant for the average married worker with three small children. He not only doesn't need this luxury in a car; he can't afford it!

• • •

We must have more engineers! For every engineer who graduates today, there are three to four companies trying to sign him up. It's up to us to constantly encourage interest in engineering.

• • •

We just can't afford to keep on wasting valuable material resources. Engineers are going to have to learn how to do without certain of the essential metals.

**Reverend William Hills**

Be sure you know how to use what you create; otherwise, it may destroy you.

• • •

Man can take the atom apart. It takes God to hold it together.

• • •

I was out on an aircraft carrier during World War II, dressed in a Mae West. Close as I ever came to anything as feminine as that.

# How a New Design Is Put Into

**G. E. Nelson,** President, G. E. Nelson Co.

Based on secretary's report of Panel on Experimental Manufacturing held as part of the SAE Aeronautic Production Forum, New York, April 20, 1953. Panel Leader was Allan Chilton, Wright Aeronautical Div., Curtiss-Wright Corp.

GETTING a new design into production is no simple matter. Underlying the whole program is the need for development of vendors and processes aimed at ultimate transition of the experimental design to the production version. Among the factors that must be considered are:

- Make or buy considerations
- Vendor development—both technical and financial
- Design-manufacturing relationship
- Mechanics of experimental-production program

## Make or Buy Considerations

Question: Is there continual discussion of designs between engineering and experimental engineering?

Answer: Most experimental procurement departments hold periodic meetings with the design engineer and representatives of experimental manufacturing and purchasing to determine make or buy considerations.

At this meeting the decision is made as to which parts will be manufactured by the prime contractor and which ones will be procured from vendors. Usually, the most critical parts are retained by the prime contractor unless there are vendors who happen to have open time and the necessary equipment to handle these specialized items.

Each prime contractor has his own make-or-buy split, depending upon the facilities at his disposal.

Question: Is experimental purchasing a part of production purchasing or is it an independent organization?

Answer: The best arrangement is to have a separate experimental purchasing department.

Question: Do prime contractors estimate the time required to produce parts?

Answer: Generally, they estimate both time and cost of all parts, especially those which are considered for purchase. These figures are very necessary in that they make it possible to compare vendor bids.

Question: How is delivery of purchased items determined?

Answer: The promise dates for any part should be related to the longest delivery time of any part needed to complete a given program. This will allow the vendor the maximum manufacturing time.

These objective dates should be revised as more realistic delivery dates become available during progression of the project.

## Vendor Development

Question: Who is responsible for securing vendors?

Answer: This is usually the responsibility of the experimental purchasing department. However, reviews of the capabilities of vendors are generally made by representatives of the experimental manufacturing group in conjunction with purchasing personnel.

Since most experimental purchases are made on the basis of fixed price or various time and material agreements, it is very important that new vendors be investigated to determine: (1) adequacy of facilities, (2) quality control methods, (3) work procedures, (4) work load, and (5) experience in the particular field in question.

Question: When operating under fixed-price, government contract, can prime contractors select the experimental vendors to be used?

Answer: Usually, prime contractors are responsible for the selection of experimental vendors. But placing of orders with these concerns is subject to government approval, requiring three bids in many cases. (The rules governing these procedures vary, depending upon the procuring agency's interpretation of them.)

Question: Is it common practice to give financial assistance to subcontractors?

Answer: In the experimental manufacturing field, it is unusual to give financial assistance to a subcontractor. This type of help can usually only be sanctioned when the parts under

# Production

consideration are tied into a production contract. (This is rarely the case in experimental work.) However, machine tools, processing information, and all types of engineering information are occasionally made available to a subcontractor without charge.

Question: Should experimental vendors engage in production work to meet expenses when they are not equipped to do experimental work at a profit?

Answer: Regardless of the type of contract employed, experimental vendors are expected to make a profit on their work. Experimental vendors should, however, develop several customers in allied lines to minimize the effect of experimental work fluctuations.

Where possible, an experimental vendor should accept responsibility to develop production capacity as a further aid to smoothing out volume fluctuations. Conversely, production vendors should accept experimental orders to maintain familiarity with new materials and processes which may be required for future, potential production parts.

It is the prime contractor's responsibility to educate and sell production vendors on the benefits of doing experimental work. It is also the responsibility of the prime contractor to maintain, where possible, sufficient volume of work with experimental vendors to keep their operations on a financially sound level.

Question: To what extent should a prime contractor assist a subcontractor?

Answer: All information pertaining to the job at hand, including material, operation sheets (when available), and engineering data, should be furnished the vendor upon request. Constant procurement and engineering liaison should be maintained to assure minimum delivery time and maximum quality.

Question: How much process engineering should a prime contractor furnish a subcontractor?

Answer: Usually, vendors determine the process engineering to suit their particular machine tools and facilities. They should be assisted by the prime contractor only on request.

Question: Are the quality control facilities of a vendor investigated before orders are placed?

Answer: When special or critical processing is involved, representatives of the prime contractor usually investigate the facilities and quality control methods used by potential vendors. This is especially true when the product is an assembly which requires inspection of all details prior to assembling.

Question: What is the solution to the quality control problem experienced with vendors?

Answer: All quality control problems can be solved by education of vendor personnel and constant improvement of the facilities being used. Responsibility for much of this lies with the prime contractor who should give every assistance possible to the vendor to maintain quality standards.

Question: Do prime contractors furnish inspection gages and fixtures to vendors?

Answer: Only in unusual cases are vendors furnished with inspection tools and gages for experimental procurement.

Question: What is the normal liaison between purchasing, engineering, and vendors?

Answer: Normal procedure is for the purchasing department to make and maintain all contacts with vendors, calling in the engineers on all processing problems. Frequent trips by vendor personnel to the prime contractor's facility also help in clearing up misunderstandings and in initiating worthwhile changes in procedure.

It is essential that experimental manufacturing inform the engineering department of variations and deviations in experimental units so that accurate records and drawings can be kept.

To minimize the problems of transition from the experimental to the production phase, some manufacturers require production personnel to

### Members of Panel on Experimental Manufacturing

**Allan Chilton,** Panel Leader
Development Director of Experimental Operations
Wright Aeronautical Div., Curtiss-Wright Corp.

**G. E. Nelson,** Secretary
President
G. E. Nelson Co.

**J. W. Chalupa**
Assistant Manager of Manufacturing
Aircraft Gas Turbine Div., Westinghouse Electric Corp.

**Karl Scheucher**
Factory Engineer
Jet Propulsion Division, Thompson Products, Inc.

**Joseph Ballard**
Chief of Experimental Operations
Pratt & Whitney Aircraft Div., United Aircraft Corp.

**P. W. Schipper**
General Manager
Douglas Tool Co.

**E. N. Laurance**
Divisional Superintendent
Glenn L. Martin Co.

participate in the manufacture of experimental and prototype parts.

## Design-Manufacturing Relationship

Question: Should designers have practical manufacturing experience?

Answer: This combination is desirable, but it is not very often found.

Question: How much should design engineers consult with manufacturing groups prior to finalizing designs?

Answer: It is most desirable to have constant contact between the design engineers and the manufacturing group prior to the release of an experimental design. If at the time the design is being processed the vendors to be used are known, this liaison should also be extended to them. In this way, practical design tolerances can be obtained.

Sometimes designs are evaluated by the production manufacturing group before release for experimental manufacture. Alternately, designs are reviewed by production departments after experimental manufacture but prior to release for prototype quantities.

Question: What happens when the experimental design results in a part that is not adaptable to production processing?

Answer: If correct evaluation by the design and manufacturing groups has taken place, there should be no parts which cannot be adapted to a production process. Very serious delays and great expense will accrue if designs cannot eventually be adapted to production methods.

## Mechanics of Experimental-Production Program

Question: What is the best way to handle the transition of an experimental design to the production version?

Answer: There are two systems used.

One system—a three-stage setup—requires an experimental department, a prototype shop, and a production facility. In this case, the experimental department is responsible for all manufacturing and testing required for acceptance of a given design. This design is then turned over to the prototype shop capable of producing a maximum of ten units per month. Production uses the experience of both the experimental and prototype departments in arranging the tooling for quantity manufacture.

In another system—a two-stage one—the experimental department manufactures the initial units and the production department fabricates the prototype and production quantities. The two-stage system requires the production department to handle all prototype requirements over and above the initial experimental quantity.

The real merits of these two systems can hardly be compared without knowing the general system of operation of the company concerned.

Question: Should the experimental department be a part of the production department or a separate unit?

Answer: It should be separated from the production department even in relatively small plants. Combining these departments would invariably wind up being detrimental to the experimental work involved.

Question: What is the best source for experimental engineering and manufacturing personnel?

Answer: To obtain the benefit of their manufacturing experience, personnel from various production functions should be upgraded to the experimental department.

Since greater skills are required by experimental manufacturing personnel, it is customary to make these positions more attractive by increasing the hourly rates for equivalent occupations and by applying a shift differential when two or three shifts are worked.

Question: Would the panel give a general outline of an experimental manufacturing procedure?

Answer: It would be scheduled something like this:

1. All parts are estimated for time and cost.
2. All parts are scheduled.
3. A tracer card accompanies parts during manufacture.
4. Schedule and progress of parts are checked periodically.
5. Tracer cards are marked by indicating a plus amount of time for parts ahead of schedule and a minus amount of time for parts behind schedule.
6. Parts marked "minus" are given priority for available manufacturing time.
7. The scheduled manufacturing day indicates the date that manufacture of the part is to start.
8. The scheduled manufacturing week indicates the time the part is to be completed.

Question: What sequence of procedures is used from design through manufacture?

Answer: The normal procedure for handling a new design, known as the project engineer's system, is as follows:

1. Project engineering releases drawings and materials to manufacturing.
2. Parts are scheduled.
3. Project planners, the manufacturing group, and experimental purchasing representatives meet daily.
4. Manufacturing group selects parts to be manufactured by prime contractor on the basis of available capacity.
5. The balance of the parts at tissue are released to the experimental purchasing agent for purchase from vendors.
6. Completed and received goods are stored.
7. Stored parts are reviewed before assembly operations are started.

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(The report on which this article is based is available in full in multilithographed form together with reports of the nine other panel sessions held at the 1953 SAE Aeronautic Production Forum, New York. This publication, SP-302, can be obtained from SAE Special Publications Department. Price: $2 to members; $4 to nonmembers.)

# WET BLASTING

## with fine particles

**W. I. Gladfelter,** Pangborn Corp.
**E. E. Hawkinson,** MicroBlast Mfg. Corp.
**A. P. Neumann and V. W. Nichols** Vapor Blast Mfg. Co.

Based on Gladfelter paper "Hydro-Finish and Hydro Sand-Blast," Hawkinson paper "Fine Particle Blasting or Micro-Blast Fluid Honing and Finishing," and Nichols paper "Fine Particle Blasting—Wet" presented at a meeting of Division XX—Shot Peening, Hot Springs, Va., Sept. 25, 1952. Division XX is a part of the SAE Iron and Steel Technical Committee.

BLASTING with fine particles suspended in a liquid has become an important process in cleaning and producing better finishes on many products these days. The functional finishes produced by this process have aided in the development of improved tool performance, better lubrication, better plate adherence, and improvements in many processing techniques.

The development of a wide range of compositions, types, and sizes of abrasive has been a feature of the process. Beginning with river sands and normal silicas, investigators discovered and produced finer and better cutting and longer lasting abrasives in quartz, novaculite, and manufactured abrasives.

The abrasive, together with approximately double its volume of water, forms a slurry which is fed to the blast gun. In the gun, the liquid stream joins with a high pressure air stream which projects the mixture against the work piece at high speed.

One of the first types of wet sand blasting machines merely added inhibited water to dry blasting. This proved unusually acceptable and was the pioneer equipment in this field. This type of equipment has recently been modernized and is expected to have many fields of application. Another type of wet sand blasting, employing coarser particles, uses water at high pressure to supply the force and injects sand into this stream to clean castings and knock out cores.

Fine particle wet blasting, known by various trade names such as "Fluid Honing," "Hydro finishing," "Liquamatting," and "Vapor Blasting" or "Liquid Honing," generally uses finer particles and produces finer finishes than the dry blasting process.

The art of blasting, both wet and dry, dates back into the 1800's. Fresh impetus was given wet blasting with fine particles in 1934 by A. H. Eppler, who pioneered in the development of special equipment for this purpose. Working with C. T. Strauss, who owned Arkansas mines of novaculite, Eppler found new and valuable applications for the process as finer and finer abrasives became available. Industrial acceptance was so enthusiastic that production wet blasting equipment soon appeared on the market. Now American Wheelabrator and Equipment Co., MicroBlast Mfg. Co., Pangborn Corp., and Vapor Blast Mfg. Co. all make wet blasting equipment for use with fine abrasives.

Novaculite, the most widely used fine abrasive for wet blasting, is a very hard quartzose rock analyzing 99.49% silicon dioxide. Nature has produced it in very firm strata, which man uses for whetstones, and in naturally decomposed veins. From this powdered state it is dried and separated according to particle sizes. It is available in many sizes ranging from 100 mesh (150 microns) down to a nominal 5000 mesh ($2\frac{1}{2}$ microns). The parti-

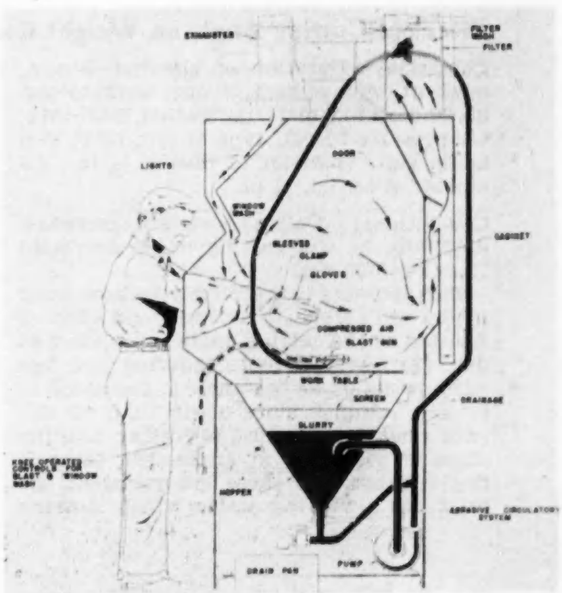
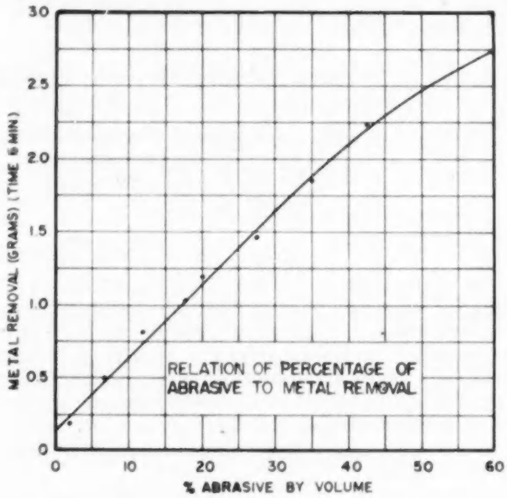



Fig. 1—Schematic diagram of equipment for wet blasting with fine particles. Detail arrangement varies among manufacturers.

# Results of Vapor Blast's Research

## Relation of Percentage of Abrasive to Metal Removal

**Conditions:** Duration of blasting, 6 min; angle of impingement, 90 deg; work-to-gun distance, 2 in.; material used, SAE 1010; air pressure, 80 psi; type of gun used, V-B angle gun; diameter of nozzle, ½ in.; diameter of air jet, ¼ in.



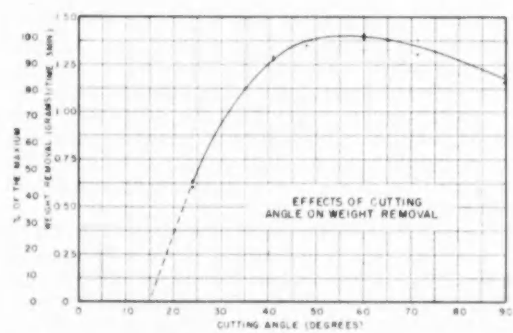

**Conclusions:** An increase in the volume of abrasive, in the water-abrasive mixture, increases the cutting action of the blast.

A 68%-by-volume mixture was obtained before excessive settling occurred. This was decided to be the stopping point from the practical standpoint of using field equipment.

The data obtained show a straight-line relation between the amount of metal removed and the percentage of abrasive used up to 43% abrasive by volume. Any further increase in the amount of abrasive used causes the slope of the curve to decrease. This flattening of the curve could be credited to the settling of the abrasive. At these high percentages, the total amount of abrasive in the machine was not circulating properly.

## Effect of Cutting Angle on Weight Removal

**Conditions:** Duration of blasting, 3 min; angle of impingement, 90 deg; work-to-gun distance, 2 in.; material treated, SAE 1010; air pressure 85 psi; type of gun used, V-B angle gun; diameter of nozzle, ½ in.; diameter of air jet, ¼ in.




**Conclusions:** Cutting action increases gradually as the cutting angle decreases from 90 to 60 deg.

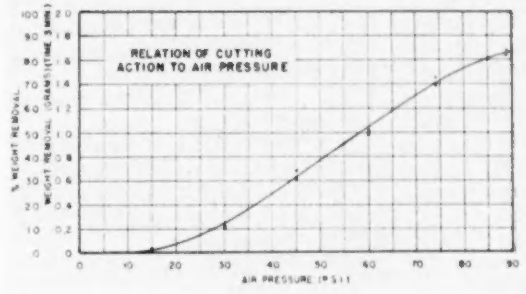
This increase can probably be accounted for by two facts: (1) The rebound effect is reduced as the cutting angle approaches 60 deg. (2) There is more scouring and less peening action as the angle is decreased to 60 deg. Angles more acute than 60 deg gave a decided decrease in cutting, and the slope of the curve at angles less than 60 deg is great. At these lower angles, the blast has a wearing action which is much slower in metal removal rates than the cutting or scouring-type action obtained near 60 deg.

## Relation of Cutting Action to Air Pressure

**Conditions:** Duration of blasting, 3 min; angle of impingement, 90 deg; work-to-gun distance, 2 in.; material treated, SAE 1010; air pressure, 85 psi; type of gun used, V-B angle gun; diameter of nozzle, ½ in.; diameter of air jet, ¼ in.

**Conclusions:** Between 30 and 75 psi the cutting action is almost directly proportional to air pressure.

At low pressure the kinetic energy of the particles is not sufficient to stress the surface of the steel beyond the failure point; hence the action is more wearing than cutting. Above 75 psi, a slight tapering off in the increase in cutting action was noted.

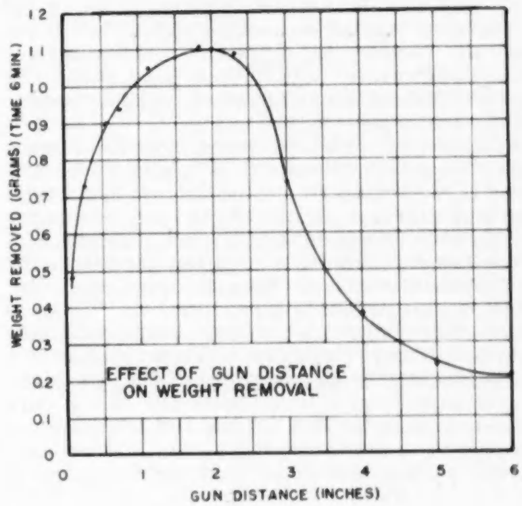



## Effect of Gun Distance on Weight Removal

**Conditions:** Duration of blasting, 6 min; angle of blast impingement, 90 deg; material treated, SAE 1010; air pressure 85 psi; type of gun, brass angle gun; diameter of nozzle, ½ in.; diameter of air jet, ¼ in.

**Conclusions:** No cutting action exists at distances less than 3/32 in. Optimum gun distance from the work is from 1.2 to 2.5 in.

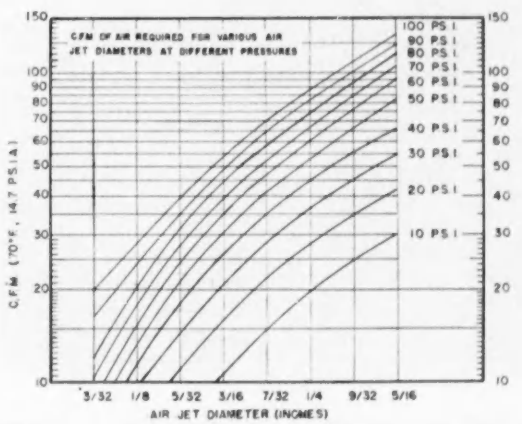
At distances closer than 3/32 in., the back pressure reflected from the plate to the gun is sufficient to restrict flow of slurry. This rebound effect causes a rapid decrease in cutting action as the distance decreases. The cutting action falls off rapidly as the distance is increased beyond 2 in.—but not proportionally to the square of the distance. The graph would, of course, vary with changes in nozzle design. (Experiments have been performed only with a standard B-20 type brass angle gun.)

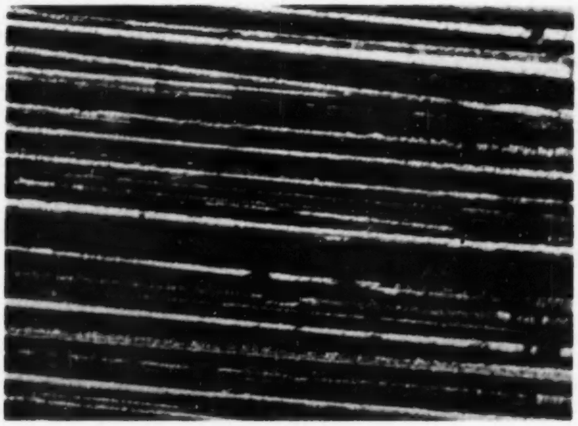



## Air Required for Various Air Jet Diameters at Different Pressures

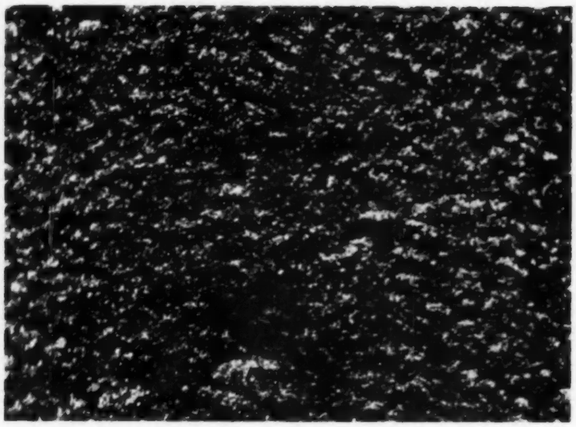
**Conditions:** Type of gun used, V-B gun; abrasive used, 140 mesh, 40% by volume; air-measuring device, Fischer & Porter flowmeters; readings taken with slurry running through gun.

**Conclusions:** Air flow required is dependent on the abrasive flow, especially when the abrasive is under pressure greater than 3 psi.





Before



After

Steel magnet end ground with 100-size aluminum oxide grit, then wet blasted with 625 mesh abrasive. Reproduced half size from 300 magnification

cles are pseudo-cubical—that is, they are six-faced crystals with rounded corners. Makers of wet blasting equipment market novaculite under such trade names as "Aweco Liquabrasive," "Microbrasive MNH," "Pangbornite," and "Vapor Blast NVB." At the present rate of consumption, the supply is adequate for many hundreds of years.

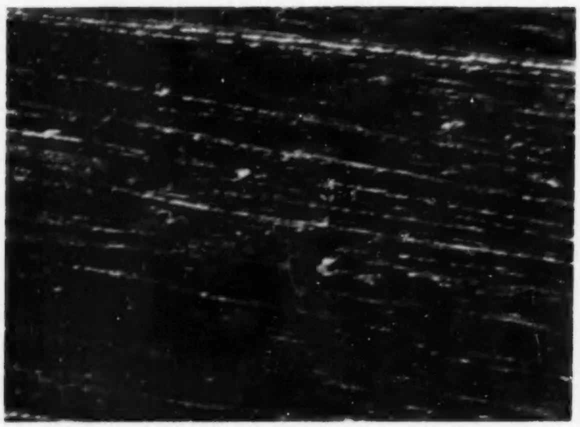
Quartz, the best of which comes from the famous Wausau deposit in Wisconsin, is available for wet blasting in mesh sizes from 60 to 300. It is a sharp-angled crystal silicon dioxide of good lasting quality. This also is in adequate supply, being so plentiful that the owners donated half of the deposit to the city of Wausau, Wisconsin to make the famous Rib Hill recreation grounds and Ski Hill.

Other natural siliceous abrasives, made from pulverized silicas and river sands, are also used in wet blasting and are in ample supply. Manufactured abrasives such as aluminum oxide and silicon carbide are also used for fast cutting and other special requirements.

All fine particle abrasives used for wet blasting tend to settle out and pack, when not being recirculated. So abrasive suppliers provide additives to help keep the abrasives in suspension, and to keep the slurry wet enough to drain rapidly from blasted surfaces and equipment walls. They also provide inhibitors to retard corrosion of equipment and ferrous parts being processed.

Fig. 1 shows a schematic diagram of wet blasting equipment for fine abrasives. A centrifugal pump recirculates the abrasive mixture to maintain suspension and delivers the slurry to the blast gun. Here the slurry joins a compressed air stream at 80 to 100 psi pressure. The gun shoots the stream at the work piece, usually from 1 to 3 in. away, with the blast impinging on the surface to be treated at an angle of from 45 to 60 deg. The slurry drains off the work piece and equipment to the hopper for re-use.

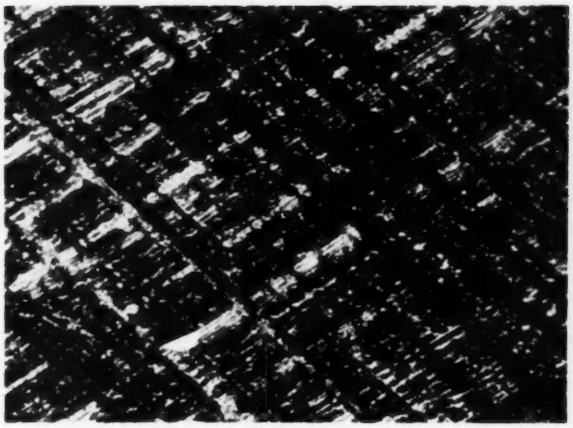
The operator manipulates the gun and work piece through armholes in the front of the machine with gloved hands. To keep his vision port or window clear from abrasive-laden fog, he presses a knee



Before

After

Steel magnet end ground with 120-size aluminum oxide grit, then wet blasted first for 1½ min with 100-mesh abrasive and then for 3 min with 625-mesh abrasive. Reproduced half size from 300 magnification



Before

After

Steel magnet end ground with aluminum oxide grit, then wet blasted with 100 mesh abrasive. Reproduced half size from 300 magnification

control which activates a clear water spray. The filter in the exhaust system is also spray washed to keep it functioning at good performance levels. To start or stop the blast and to control the air pressure, the operator presses another knee valve.

Machines have been built using several differing techniques, such as air agitation for abrasive suspension and venturi action for delivery of slurry to gun, but pumps have proved more efficient and economical for both purposes.

Delivery of the slurry to the gun under pressure (from pressurized tank or by pressure pumping) has been employed with success for spray head nozzles, long nozzles, small diameter nozzles, and for other special guns. Although design and function of manual machines has been pretty well standardized, many special machines for unusual and high production uses are continually being designed, developed, and built.

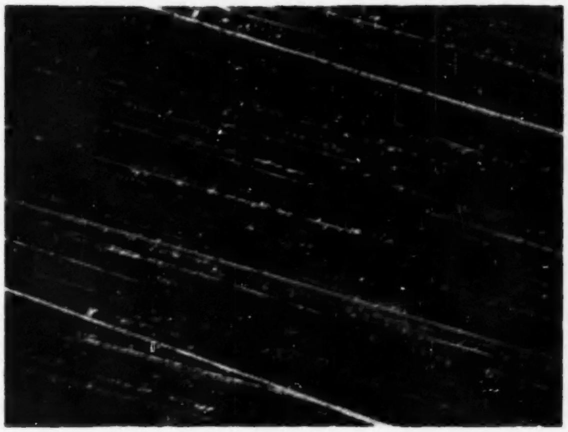
Users can procure fine particle machines with tracks, turntables, rotating devices, multiple gun manifolds, special guns for angle or lance blasting, gun oscillating mechanisms, and automatic rubber lined tumbling barrels.

### Applications

Fine particle blasting guns benefit a great variety of products. They are used to clean off heat-treat scale and corrosion, remove fine burrs, blend tool marks, smooth turbine blades, produce special lustrous or frosted finishes, and make micro rough surfaces.

Fine particle blasting can remove some types of heat-treat scale with only infinitesimal dimensional change on precision parts. Even heat-treat salts in small amounts disappear. The process is often used before shot peening to prevent contamination of shot by scale. After shot peening, parts can again be blasted without losing effects of the peening.

Cleaning and finishing plastic molds and dies by fine particle blasting is relatively fast, too; users report as much as 95% reduction in bench time. What's more, blasted molds release castings more



Before

After

Steel magnet end ground with 220-size aluminum oxide grit, then wet blasted with 625-mesh abrasive. Reproduced half size from 300 magnification

easily than hand-finished ones.

Fine particle blasting will take rust off salvaged automobile and aircraft parts and make them reclaimable if corrosion has not progressed too far. In fact, the process will remove any metallic oxide, including tough chrome oxide formed on stainless steel. Machined parts subjected to blasting lose their burrs and tool marks. Gears are said to have smoother profiles and run quieter. Tools like broaches, gear hobs, milling cutters, reamers, and drills show great improvements in cutting life. For example, an involute spline broach normally had to be sharpened at least every 12 pieces to stop pick-up and galling on the tooth side. After treatment, the broach produced 496 pieces before it needed sharpening. The same broach, without further blasting treatment, averaged 530 pieces between sharpenings or polishings for the next 7000 pieces.

Life of hobs was also increased as much as 240%. Milling cutters that produced only 17 pieces per grinding before treatment produced up to 300 pieces per grind after treatment. Small ratchet wheel hobs ran 6 hr instead of 2½ hr between grinds. Hundreds of similar cases are on record.

The reasons for the remarkable improvements in tool life are, probably, that the resulting non-directional finish on rake surfaces holds the cooling oil better, giving better chip flow and lower heat rise. More important, removal of the tiny burrs on the tool lessens its tendency to pick up metal.

The non-directional surface is made up of very, very shallow valleys. Capillary action draws the lubricant in, and it stays right where it's needed. This finish improves wear resistance characteristics of production cylinder walls and ball bearings markedly, and salvaged parts cleaned by fine particle blasting sometimes run better than new ones because of the better lubrication.

Surfaces produced by this process are ideal, too, for painting, bonderizing, electropolishing, fluorescent penetrant or magnetic particle inspection, and plating. Fine particle blasting, because it increases adherence, can reduce plating time, save plating materials, and permit close-tolerance plating (eliminating final grinding operations). Welding, brazing, and silver soldering also benefit from the clean surface this blasting leaves.

Depending on particle size, wet blasting can smooth or roughen a surface. New abrasives are under development to put bright, easy-to-read scales on machine parts. Other abrasives give satin or matte finishes on anodized aluminum or on chromium plate. Relatively coarse abrasive will frost glass for markings and decoration.

Some of the more unusual uses reported for fine particle blasting are: removing the luster from plastic fish line, weathering wood for decorative purposes, salvaging internal threads shrunk during heat treatment, revealing discontinuities prior to fluorescent penetrant or magnetic particle inspection, peening very thin material, and locating high spots interfering in close fits.

New uses crop up continually.

# Cheaper Power . . .

**. . . results when British Columbia towns switch from diesel fuel to bunker oil for their diesel electric generators. Use of natural gas brings even greater savings.**

Based on paper by **J. A. Brynelsen** Simson-Maxwell, Ltd.

GREAT savings can be had by using bunker fuel in marine and stationary diesel engines. For power-generating stations in the remote parts of British Columbia, the switch from diesel fuel to bunker oil can effect savings adequate to pay for the entire installation of a 1,000,000 kwhr per month powerplant in five years.

Use of bunker fuels requires no basic change in fuel pumps, nozzles, or other units. The major requirement is fuel preparation—consisting basically in fuel cleaning and heating. Complete removal of all abrasive and other solid materials is most important if rapid wear and sticking of the fuel pumps and nozzles is to be avoided.

Bunker fuel contaminates lubricating oil at an accelerated rate. Entire dependence should not be placed upon the pack type of filter for oil clarification as its life is relatively short. A centrifuge is a valuable asset because contaminants are reasonably easy to remove.

Operating records prove that wear rate and maintenance are no greater with bunker fuels. If an engine is to operate intermittently, a duplicate fuel system should be installed to allow flushing of the system with diesel oil before shut-down.

Still greater economies can be achieved in power generation by using natural gas when such is available. Beside the overall thermal efficiency of the gas-diesel, which is over 40%, there is the added economy of the relatively low cost per Btu of natural gas as compared with diesel or bunker fuels. There is also a decrease in maintenance and oil consumption which contributes to the lower cost per kwhr.

Use of natural gas in place of diesel fuel in the operation of a 1,000,000 kwhr per month power installation would effect savings sufficient to pay for the entire installation in two years. (Paper "Cheaper Power Costs by the Use of Bunker Fuels and Natural Gas in the Internal Combustion Engine" was presented at SAE British Columbia Section, Vancouver, B. C., March 9, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

# Did You Know That . . ?

**C. H. Johnson,** Peninsular Grinding Wheel Sales Corp.

Report on Panel on Grinding and Cutting Tools held at SAE National Production Meeting, Cleveland, March 25, 1953. Panel leader was A. Karabinus, Thompson Products, Inc.

## *In Grinding*

Special hard grades of carbide are tough to grind because of the difference in expansion of the two metals. Soft grades of resinoid-bonded diamond wheels have been tried with a coolant; but this isn't very effective. $CO_2$ doesn't seem to help either. Experimental use of a cold braze method hasn't brought any results yet. Nor has the use of different speeds using silicon carbide wheels.

In grinding titanium, the consensus seems to be to reduce wheel speeds and to increase feed. Sulfurized oils seem to offer some help. In some cases, silicon carbide wheels do a good job. But in most cases aluminus oxide vitrified wheels show the best results.

To remove grinding checks on plated parts, this appears to be a good procedure: Use an aluminus oxide vitrified wheel for grinding and then go to a 180 grit shellac wheel. This gives the parts a fine finish. Then bake the parts in an oven before plating. All traces of grinding check seem to be eliminated by this method.

An oil coolant for form grinding has proved beneficial in most cases. Keeping the oil cool with refrigerated units increases the number of pieces per dress. Fine grit wheels will cut better, hold form better, and give more pieces per dress by using oil instead of a water soluble mixture as a coolant. Using oil permits use of a finer grit wheel.

In grinding broaches, you get best results with wet rather than dry grinding. However, some machines available today are not adapted for wet grinding and they give good results with dry grinding. $CO_2$ coolant has proved itself advantageous in broach grinding.

In some cases you can remove grinding pits by using fine grit shellac wheels on the parts. But sometimes grinding pits caused by the rougher grinds are so deep they can't be eliminated in the finish grinding.

## *In Coolants*

In many states it is against the law to use carbon tetrachloride as a coolant. In most cases where it is used as a coolant it tends to have a toxic effect on operators. But when

used, it should be diluted because it may cause sterilization of the people using it.

The new types of coolants, such as the more active sulfur and chlorinated oils, help increase the life of broaches and cutting tools.

There is no doubt that use of high jet or mist spray does increase tool life. But the high jet generates a lot of smoke, so machines have to be hooded. This prevents the operator from seeing the works. Tools must be ground accurately when using high jet spray; otherwise the spray will be deflected and will not serve its purpose. Research is being directed toward improving pumps for high jet units and using soluble oils.

Some feel that $CO_2$ is beneficial in grinding, others don't agree. But all are in accord that it's an expensive process. A number of improvements are needed. Nozzles or jets don't seem to provide uniform flow of the $CO_2$ gas. It's a hazard to the operator . . . the extreme cold is harmful to his hands. In most cases gloves must be worn. The intense cold doesn't seem to harm the grinding wheel. In grinding broaches, heat checks have been reduced considerably. $CO_2$ gas does help increase stock removal in grinding carbide. But you can get almost the same result by applying the coolant through the wheel.

## *In Carbides*

On the majority of small screw machines it is not profitable to use carbide tools. That's because you cannot speed up the machine to make the cutting efficient. So most of the time it is better to use high-speed tools.

Better brazing methods may be one way of keeping carbide tool tips from coming off. A number of such new methods are now on the market and experimentation in this direction may solve the problem.

In no case has the spraying of tungsten carbide on cutting tools proved beneficial. But it seems to have worked very well on punches.

Solid carbide taps can be used in tapping aluminum. In most cases a lead screw head should be used. Chlorinated oils seem to be the best coolant. In tapping blind holes, it helps to fill all the holes with coolants to eliminate air pockets.

Several shops have formed carbide by heating, usually in an induction furnace, to give a spiral effect on cutters. This has proved very effective in some cases because the helical form imparts a shearing action to the tool.

## *In Drilling*

Although cast iron is gun drilled every day, there are little things that can be done to improve the operation. Improvement can come from increasing oil pressures. Sometimes filters have to be added. Cutting speeds should be around 180 fpm. And tools must be aligned so that they drill true.

There are several ways of drilling stainless steel effectively. Both cobalt drills and carbide spade drills do a good job. A 15-deg negative rake should be put on the tool to break up the chips. On all blind holes or deep holes, a gun drill is the most effective tool.

In drilling large diameter work, trepanning or woodpack tools have worked well. The tools tend to cut straight holes which facilitate honing. In some cases, nylon or plastics have been used in place of woodpack.

## Members of the Panel on Grinding and Cutting Tools

**A. Karabinus,** Panel Leader
Assistant Division Manager
Valve Division
Thompson Products, Inc.

**C. H. Johnson,** Panel Secretary
Peninsular Grinding Wheel Sales Corp.

**George Pascoe**
Manager, Design and Standards Department
Manufacturing Engineering Office
Ford Motor Co.

**J. G. Gaul**
The Cleveland Pneumatic Tool Co.

**W. B. Shimer**
Assistant Master Mechanic
DeSoto Division
Chrysler Corp.

**O. Preston Lowry**
Supervisor of Method and Development
Aircraft Division
United Aircraft Corp.

## *In Cutting Tools*

Surface finish on tools may increase tool life, depending on tool application. On some jobs, for example, a rough tool does better work. On tools where the top tends to crater, it is better to have a fine finish. Some shops vapor blast their tools and others use chrome plate. But again this may be helpful on some work, harmful on others.

Don't let hobs wear beyond 0.015 in. If hobs are allowed to wear much more than this, the cost of regrinding becomes prohibitive. In fact, some sort of control should be established on all type cutting tools to keep them from wearing beyond their limit. Some shops have established controls on their machines which automatically record tool life. Tools are changed in the setup before they break down too much. On machines with multiple tools, it has been found worthwhile to change all or most of the tools when one tool nears its end point. This cuts down time for setup and tool change. Single-point tools never should go beyond 0.030 in. wear.

In nearly all cases a radius cutter will hold up better than a 45-deg chamfer on both high-speed and carbide tools. It seems that the corners on the chamfer tools tend to break down more rapidly. In some cases, a chamfer tool can be made using two 22½-deg chamfers instead of a 45-deg one. There are places where this can't be done.

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The report on which this article is based is available in full in multilithographed form together with reports of seven other panel sessions of the 1953 SAE Cleveland Production Forum. This publication, SP-301, is available from the SAE Special Publications Department. Price: $2.00 to members, $4.00 to nonmembers.

# Air Challenges Oil

# for Job as

PNEUMATIC actuating systems look to a brighter future in the U. S. Air Force. For many years they've been overshadowed by hydraulics, but 10 years of USAF development and testing—and tomorrow's supersonic planes—may very well change all this.

Interest is increasing in pneumatic systems because a decade of developing and testing systems for military planes has shown that:

- Pneumatic systems can be reliable.
- Pilots like the operation.
- Mechanics enjoy the cleanliness.
- Maintenance is simple.
- Weight saving is achieved. (Primarily due to the small lines used, the complete lack of return lines, and the small weight of air as compared to weight of hydraulic fluid necessary.)

At the same time, tomorrow's jet planes that will ram through the air at supersonic speeds will literally put the heat on actuating systems. (At these high speeds, air, upon striking the surfaces of an airplane, experiences isentropic compression, with subsequent heating.) And this heat will be tougher to handle with hydraulic than with pneumatic systems.

Why? Because with pneumatics it will be sufficient to cool the compressor only, but with hydraulic systems it will be necessary to cool the actuating fluid too. Rather than have an adverse effect on the air in pneumatic systems, the high temperatures encountered may very well impart a small amount of energy to it.

#### Pneumatic Actuation Isn't New

Actually, the use of pneumatics in aircraft is not new. In the early 1920's air brakes were used in British, French, Italian, and other foreign aircraft. During this period, engine starting by compressed air was extensively used in Europe.

Today, almost all British aircraft use air brakes . . . and great efforts are being made to further the use of pneumatic actuating systems in England. The small but effective Swiss Air Force has used pneumatic actuating systems for many years. A Russian YAK-9 fighter obtained by this country some years ago also was found to contain a pneumatic system. This system actuated brakes and provided energy for starting.

In this country, use of pneumatics did not progress beyond the starter application—and even this application disappeared. Pneumatic actuation did not reappear until many years later.

#### Pneumatics a Must for B-29's in 1943

What might be considered the first modern application of pneumatic actuation in the U. S. Air Force occurred on the first B-17 and on all B-29's in 1943. In these aircraft, air was used to operate the bomb doors and gun turrets. (The bomb doors had been electrically operated. But they required 7 sec to open and even more time to close . . . and, as the enemy well knew, this time interval was too long. He would wait at a safe distance and when he saw the bomb doors open for the bomb run, he would close in for attack.) By installing pneumatically operated doors, the actuating time was reduced from 7 sec to 0.8 sec, and this was accomplished without a significant weight change. The storage pressure used in this system, 1500 psi, was considerably higher than any pressure ever before used in aircraft. The compressor was motor driven.

After World War II ended, aircraft designers could spend more time on basic aircraft improvement. Thus, a study was made of the different methods of actuating various aircraft components.

It was found that all components except control surfaces require actuation only once or twice during flight. Control surfaces in high-performance aircraft require continuous power of high magnitude and cannot be economically serviced by a

# Jet Pilot's Man Friday

**Natural physical characteristics of pneumatic systems put them in a good position to vie with hydraulics for the actuating job in supersonic jets. Lighter weight and less susceptibility of air systems to heat are points pneumatic boys can really sell.**

**Robert R. Bayuk,** Wright Air Development Center

Based on paper "Pneumatic Actuating Systems in the U. S. Air Force" presented at SAE National Aeronautic Meeting, New York, April 22, 1953.

storage-type pneumatic system. This service, then, was the only one which did not appear feasible for air actuation. All the others—brakes, landing gear, flaps, bomb doors, canopy release, and other specialized services—seemed ideal for actuation by pneumatics.

In 1946, the USAF sponsored the development of a complete pneumatic actuating system for the B-26 attack-bomber. This was done to provide a basis for comparison with the existing hydraulic system.

This system was installed with off-the-shelf components. It operated very satisfactorily for several years, first with three motor-driven compressors and then with an engine-driven unit. (The single engine-driven unit weighed less than one of the electric units.) Air stored at 1500 psi was used at various reduced pressures for actuating purposes. This system operated landing gear, brakes, bomb doors, and flaps. A weight saving of 11% was achieved, and it is estimated that with judicious design in a new airplane of this type, a 30% weight saving could be achieved.

### What Pneumatics Offer

The chief lessons learned from this program were: (1) pneumatic systems can be reliable, (2) pilots like the operation, (3) mechanics enjoy the cleanliness, (4) maintenance is simple, (5) weight saving is achieved, and (6) leakage is a problem, particularly at low temperatures. Surprisingly, freezing of the valves, which had been expected, never occurred.

The B-46 medium jet bomber (by Convair) was another airplane (1946) equipped with a pneumatic actuating system. Attesting to the rapid actuation possible with pneumatics, this was the first airplane in which the landing gear could be retracted in less than 5 sec. This airplane was never put into production; so the pneumatic system was not further developed.

However, to uncover operational problems, this system was given a cold-weather evaluation test at the Eglin Field Climatic Hangar in 1947. In general, the system performed satisfactorily, but freezing of some components and air leakage did occur.

The freezing problem could be completely eliminated by reducing the vapor pressure of the water in the air to the point which would prevent formation of ice. (In accordance with the laws of partial pressure, compression of air will automatically remove 99.0% of the water at 1500 psi and 99.5% at 3000 psi.) Providing a drying agent such as silica gel has since been found to be a satisfactory way to remove the remaining moisture.

Regarding air leakage, care must be exercised to assure a tight connection at low temperatures. New fitting developments are in progress to alleviate this problem.

The XB-48, in 1948, was another completely

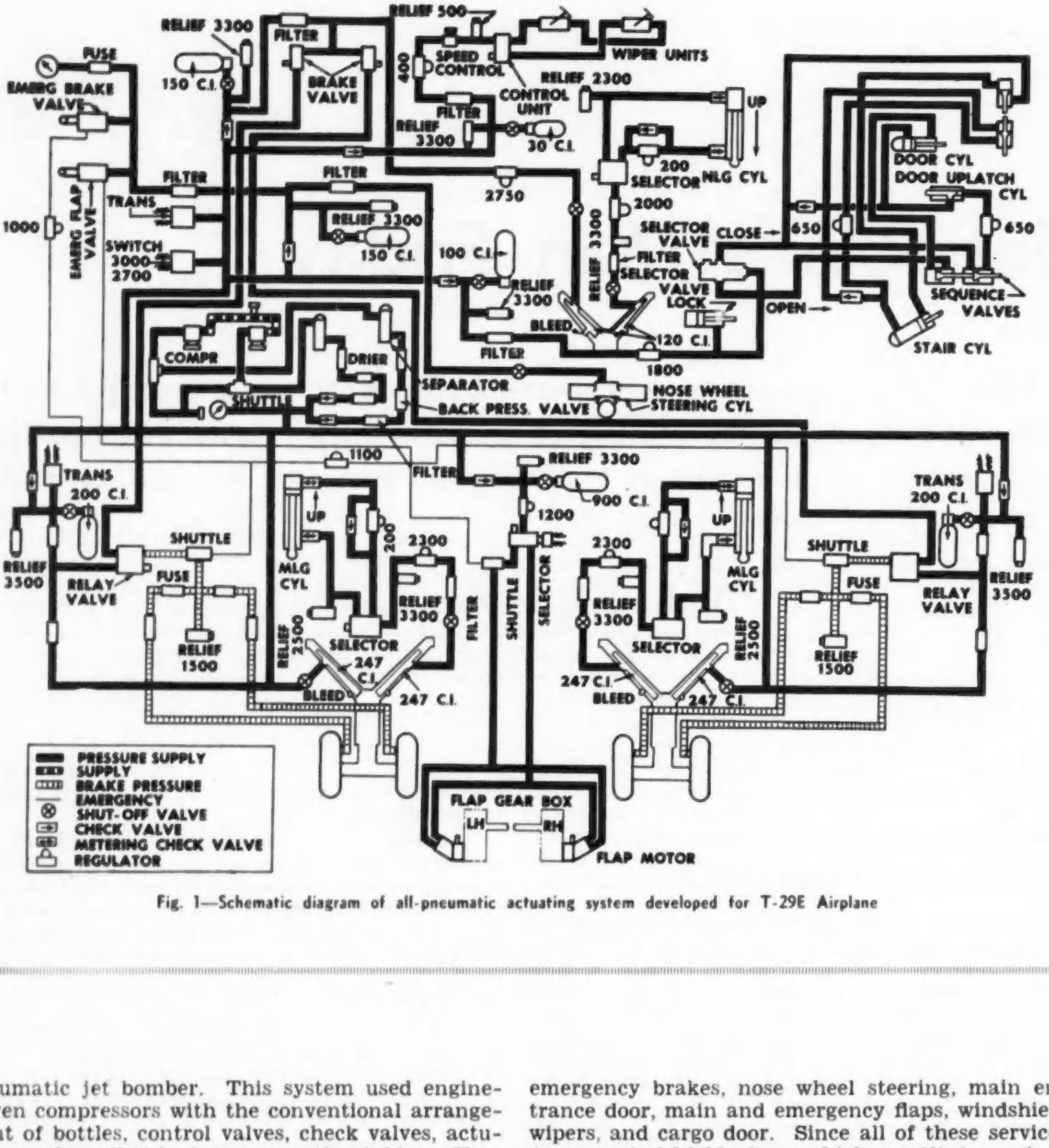


Fig. 1—Schematic diagram of all-pneumatic actuating system developed for T-29E Airplane

pneumatic jet bomber. This system used engine-driven compressors with the conventional arrangement of bottles, control valves, check valves, actuators, and small 1/4 in. interconnecting tubing. Here again, the airplane never went into production; so the pneumatic system development was dropped.

Still another pneumatic actuating system, and one which has reached production, is in the F-84. This system has been discussed in previous papers.

The latest all-pneumatic installation was proposed for the T-29E or Convair 340 airplane. (I say "proposed" because here too, unfortunately for pneumatics, this airplane never reached production in the U. S. Air Force, and the pneumatic system did not progress beyond the design stage.) This is a two-engine transport requiring actuation of main landing gear, nose landing gear, main and emergency brakes, nose wheel steering, main entrance door, main and emergency flaps, windshield wipers, and cargo door. Since all of these services (except windshield wipers which constitute a minor requirement) require intermittent actuation, pneumatic actuation lends itself readily to servicing them.

## Weight Comparison

A detailed weight comparison between this pneumatic system and a comparable hydraulic one is given in Table 1. The pneumatic system weighed 338 lb and the equivalent hydraulic system 433 lb or a weight increase of 29% over pneumatics. To reduce the number of storage bottles that would otherwise be required, part of the air in the pneu-

matic system was stored in the landing gear struts. The compressors constituted a large part of the weight—64 lb. They were motor-driven since it was not possible to mount them on the engine. If this could be done by redesign, compressor weight could be cut in half.

### How A Pneumatic System Works

A schematic diagram of the system is shown in Fig. 1. Air taken from the pressurized cabin is compressed to 3000 psi by two 200-v, alternating-current, 400-cycle, motor-driven compressors. (These compressors are arranged to feed in parallel into the system. Failure of one compressor will not hinder the operation of the other, due to shuttle valves in the lines.) The air is then routed to moisture separators, one for each compressor. These separators impart centrifugal motion to the incoming air and assist in trapping 99.5% of the entrained moisture. They automatically eject the accumulated moisture at each shutdown of the compressors. A chemical dryer such as silica gel is used to remove the remaining moisture.

A pressure-actuated electric switch allows the compressors to maintain 2800-3000 psi main pressure. A check valve placed downstream from the driers serves to isolate the main system from the compressor system.

All this equipment is connected with ¼ in. tubing and is mounted on a panel, together with a cockpit indicator. All of it, excluding the compressors, is small, weighing a total of 10.9 lb.

The main pressure system supplies air to both legs of the two main landing gears which are isolated by check valves. Sufficient air is stored in the struts to permit three landing gear cycles. The air is led through a reducer to a selector valve which is mounted in the nacelle. Air pressure is 2300 psi for retraction and 50 psi for extension.

The nose landing gear system is also isolated by a check valve and similarly arranged. Air for this gear is stored in one leg only. (Air in the other leg is used for nose wheel steering and as an emergency supply for brakes and flaps.) All landing gear can be retracted and extended several times without further air from the main system.

The brakes located on the main landing gear wheels are supplied by separate bottles from the main line. They are isolated by check valves. The main power brake valves are supplied by a bottle which is charged from the main line and isolated from it by a check valve. Upon applying the brakes, pressure from the brake valves actuates relay valves which allow pressure from the main brake bottles to actuate the brakes.

The windshield wiper receives air from the main line through a reducer which drops pressure to 100 psi. Speed is controlled by a regulating valve located in the cockpit.

The flaps are operated by air motors which receive air from an isolated storage bottle through a reducer. The flap motors are synchronized through connecting shafting. Provision is also made for emergency operation of the flaps. This is made possible by a shuttle valve which allows air from the emergency storage bottle to operate the flap motors.

Pressure for the cargo door is taken from an independent storage bottle which is isolated from the main system by a check valve. The door operation is controlled by a manually operated selector valve.

The entrance door and stairs are controlled by normally operated selector valves. Here again, the air is supplied by a storage bottle, which is isolated from the rest of the system by a check valve.

Controls for emergency operation are mounted on the pilot's console. The entire pneumatic system is properly instrumented with gages located in the cockpit.

### When Air and Oil?

Thus, a number of pneumatic actuating systems have been developed and tested by the U. S. Air Force. However, use of pneumatics to date has not been determined by its advantages as an actuating system, but rather for its ability to supply air to equipment which cannot be operated in any other way. Many of our military aircraft use pneumatic systems, but in no case to date has the pneumatic system completely replaced the hydraulic system for primary actuation.

The fact that pneumatic actuation can be accomplished by hydraulics, which we know so much more about, is often presented as a reason for disqualifying pneumatics. But if pneumatic systems are lighter, we should use them. And if a combination of hydraulics and pneumatics is best, we should use it.

In short, each new airplane should be separately and completely studied. In every case the use of pneumatics should be carefully considered, even though the weight of experience favors hydraulics.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

**Table 1—Weight Comparison of Hydraulic versus Pneumatic System for T-29E Airplane**

| Item | Hydraulic lb | Pneumatic lb |
|---|---|---|
| Main power system | 55.49 | 74.90 |
| Auxiliary power | 15.40 | |
| Landing gear | 51.60 | 94.00 |
| Brake system | 8.20 | 43.80 |
| Windshield wiper | 5.85 | 4.40 |
| Nose steering | 14.70 | 15.50 |
| Flap system | 8.05 | 13.10 |
| Entrance door | 7.80 | 12.10 |
| Emergency pressure | 6.25 | 4.90 |
| Fluid | 95.00 | 16.00 |
| Tubing, hose fittings | 135.00 | 50.00 |
| Tube supports | 30.00 | 10.00 |
| Total | 433.34 | 338.70 |

# National Meetings . . .

| Meeting | Date | Hotel |
|---|---|---|
| | **1953** | |
| International Production | Oct. 29-30 | Royal York Hotel, Toronto |
| Transportation | Nov. 2-4 | The Conrad Hilton, Chicago |
| Diesel Engine | Nov. 3-4 | The Conrad Hilton, Chicago |
| Fuels and Lubricants | Nov. 4-6 | The Conrad Hilton, Chicago |
| | **1954** | |
| Annual Meeting and Engineering Display | Jan. 11-15 | The Sheraton-Cadillac Hotel and Hotel Statler, Detroit |
| Passenger Car, Body, and Materials | March 2-4 | Hotel Statler, Detroit |
| Production Meeting and Forum | March 29-31 | The Drake, Chicago |
| Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display | April 12-15 | Hotel Statler, New York City |
| Summer | June 6-11 | The Ambassador Atlantic City, N. J. |
| West Coast | Aug. 16-18 | Hotel Statler, Los Angeles |
| Tractor and Production Forum | Sept. 13-16 | Hotel Schroeder, Milwaukee |

# L. Ray

THE L. RAY BUCKENDALE LECTURES, to honor the aims and ambitions to which SAE's 1946 President devoted his inspiring and fruitful professional life, will be inaugurated next year by the Society of Automotive Engineers. Establishment of this new lecture series results from SAE Council's acceptance of a proposal of the Timken-Detroit Axle Charitable Trust No. 2 that SAE establish and administer an L. Ray Buckendale Lecture series with funds provided for that purpose by the Trust. The Timken proposal was generated by a suggestion of Walter Rockwell, until last month the President of Timken-Detroit Axle Co.

In accepting the proposal, SAE Council pointed out: (a) that through this lecture series, it would provide annually an automotive engineering lecture by a distinguished authority in the technical areas of commercial or military ground vehicles; and (b) that emphasis in the Lectures would be on the needs of young engineers; and that each lecture would aim to provide up-to-date knowledge, not generally available in textbooks.

Detailed procedures for development and operation of the lecture series were recommended to Council at its September 17 meeting by a five-man committee appointed at its June 11 meeting to perform this single task. (See accompanying illustration.)

Important among the now-approved recommendations of this special committee was that the Lectures be administered by a five-man L. Ray Buckendale Lecture Committee, appointed by the president of the Society. This Lecture Committee will each year select both a Lecturer and a topic for a lecture. President Robert Cass, following adoption of the recommendations, appointed the following Lecture Committee:

L. Ray Buckendale Lecture Committee
Dale Roeder, chairman
L. W. Fischer — A. L. Boegehold
E. P. Lamb — C. E. Frudden

This is the Committee which will select the first L. Ray Buckendale Lecturer—for 1954. Announcement of its selection is expected before February, 1954.

In selecting the Lecturer, to whom will go an award of $250 and a certificate, Chairman Roeder's Committee will be guided by the following regu-

# Buckendale Honored

lations set up by the SAE Council to govern administration of the Lectures:

1. The Lecture shall fall within the field of on or off the road commercial or military vehicles.

2. Within these broad fields, gear trains and metallurgy shall be emphasized when feasible.

3. Lectures shall be directed toward filling the needs of young engineers and students for up-to-date, practical knowledge not generally found in textbooks.

4. Qualifications of the Lecturer shall include distinction in and knowledge of the particular subject selected, speaking ability, and willingness to produce a monograph and to address a national meeting of the Society, or a meeting of one of the Sections or Student Branches, as may be determined by the Lecture Committee.

The first L. Ray Buckendale Lecture will be given sometime during the Calendar year of 1954.

The late L. Ray Buckendale (right) with Walter Rockwell

## Buckendale Lecture Proceedings

Procedures for operating the newly-established L. Ray Buckendale Lectures were designed by this temporary committee prior to appointment of an L. Ray Buckendale Lecture Committee to administer the series.

Chairman of the temporary committee was SAE Past President B. B. Bachman (left). Others of the committee in the picture are (left to right) R. P. Lewis, SAE Past President Dale Roeder—who has been named chairman of the L. Ray Buckendale Lecture Committee, M. A. Thorne, and E. F. Petsch. Also a member of the temporary committee was C. G. A. Rosen.

# SAE International Production Meeting and Forum

## Royal York Hotel, Toronto, Ont., Canada Oct. 29-30, 1953

## PRODUCTION FORUM

### Thursday, Oct. 29

Chairman—**COL. M. P. JOLLEY,** Canadian Acme Screw and Gear, Ltd.

**Eight separate informal gatherings as outlined are arranged to exchange information and experience on vital production problems. Each group will have a panel of specialists available to answer questions and to discuss problems.**

**The forum is designed to serve a useful purpose to men at all levels in organizations engaged in production of materials and manufactured goods. Top executives, department heads, supervisors, engineers and others will find an abundance of information available.**

All Panel Discussions 10:00 a.m. to 12:00 Noon—2:00 p.m. to 4:00 p.m.

### FORGINGS

In the design of closed die forgings for critical applications, mutual study by the user and the forging engineer is required for the most effective and economical application. Maintaining costs at a minimum requires constant evaluation of latest forging, heating and die sinking techniques. Flexibility for low volume and varied production versus optimum performance for high volume is a major factor in the economic selection of machinery and techniques.

Panel Leader:
**A. W. Hollar,** Assistant General Manager, Dominion Forge and Stamping Co. Ltd.

Panel Secretary:
**H. Kilborn,** Assistant Secretary-Treasurer, Drop Forging Association

Panel Members:
**W. D. Carruthers,** Vice President, Hayes Steel Products Ltd.
**H. Crawford,** General Foreman of Forge Shop, Thompson Products, Ltd.
**G. G. Fristoe,** Vice President, The Ajax Manufacturing Co.
**C. F. Hill,** Manager, Electro Forge Div., Massey-Harris Co. Ltd.
**G. W. Motherwell,** Vice President, Wyman-Gordon Co.
**M. S. Reed,** Vice President, Erie Foundry Co.
**E. H. Zuern,** Master Mechanic, Oldsmobile Forge Div., General Motors Corp.

### FOUNDRY OPERATIONS

The panel will discuss and answer questions pertaining especially to shell molding, shell molding versus sand molding and comparative cost factors, plaster cores, nodular iron, statistical quality control within the foundry, mechanization, coordination among design engineers, pattern makers and foundry operators and other problems involved in foundry operations.

Panel Leader:
**A. Reyburn,** Foundry Superintendent, Cockshutt Farm Equipment Co.

Panel Secretary:
**W. Bryce,** General Foreman, Grey Foundry, International Harvester Co. of Canada Ltd.

Panel Members:
**Alex Barczak,** Works Manager, Superior Foundry Inc.
**F. W. A. Baulch,** Works Manager, Etobicoke Works, Aluminum Co. of Canada Ltd.
**J. Perkins,** General Superintendent of Production, Foundry and Heat Treat Plant, Ford Motor Co. of Canada Ltd.
**A. Pirrie,** Manager, Dufferin Works, Standard Sanitary and Dominion Radiator
**G. P. Phillips,** General Supervisor, Foundry Research, Manufacturing Research Department, International Harvester Co.

### MATERIALS AND HEAT TREATMENT

With the rapid industrial expansion that is taking place at the present time in Canada, a wider variety of steels is coming into common use. These steels, their uses, heat treatment and pitfalls in their treatment will be discussed.

Substitute steels forced on us by the present shortage of critical metals will also be a subject for debate.

Panel Leader:
**J. R. Mott,** Chief Metallurgist, Canadian Acme Screw and Gear, Ltd.

Panel Secretary:
**J. Bavington,** Assistant to Plant Engineer, Canadian Acme Screw and Gear, Ltd.

Panel Members:
**H. B. Chambers,** Metallurgist, Atlas Steels Ltd.
**J. S. Edgar,** Vice President, Engineering, Thompson Products, Ltd.
**R. W. Roush,** Materials Engineer, Timken-Detroit Axle Co.
**I. Reid,** Manager of Foundry and Heat Treatment, Ford Motor Co. of Canada Ltd.
**R. Smallman-Tew,** Metallurgist, Airframe Div., A. V. Roe Canada Ltd.
**E. H. Stilwill,** Metallurgist, Dodge Div., Chrysler Corp.

### PRODUCTION CONTROL AND MATERIALS HANDLING

(a) What is the position of production control in modern industry? What are its functions? What new developments are under way? Will your present system give proper results in a buyers' market?

(b) How does materials handling relate to production control? Why is materials handling so important in modern industry? How does it affect plant layout and design? What can materials handling engineering do for your company?

These and other question the panel will be prepared to discuss.

Panel Leader:
**J. G. Craig,** Director of Planning, Chrysler Corp. of Canada Ltd.

Panel Secretary:
**B. I. Booth,** Superintendent of Planning, Chrysler Corp. of Canada Ltd.

Panel Members:
**J. E. Adams,** Director of Purchases and Planning, The White Motor Co.
**C. A. Atkins,** General Superintendent, Planning and Material Control, Ford Motor Co. of Canada Ltd.
**Harry Diefendorf,** Consultant and Material Handling and Packaging Engineer, Detroit
**H. O. Horning,** Material Handling and Packaging Engineer, Staff Master Mechanics Div., Chrysler Corp.
**K. B. McNaughton,** Sales Manager, Sheet, Strip and Plate Tin Div., The Steel Co. of Canada Ltd.
**C. A. Rogers,** Production Manager, McKinnon Industries Ltd.

### PRODUCTION TOOLING AND SHOP METHODS

This panel is composed of specialists in metal-working shop practices as applicable to Canadian automotive and aircraft production. The panel will discuss various problems in fields of carbide tooling, precision grinding, heat treatment and metallurgy of tools, special machine design and application, cutting fluids and lubrication, tool design and application, hobs and broaching.

Panel Leader:
**Edgar Barker,** President, Modern Tool Works Ltd.

Panel Secretary:
**R. E. Crawford,** Editor, Canadian Machinery and Manufacturing News

Panel Members:
Carbide Tooling: **Sinclair Wilson,** Carbide Tool Application, Field Engineer, A. C. Wickman (Canada) Ltd.
Precision Grinding: **F. G. Harris,** Field Abrasives Application Engineer, Norton Co. of Canada Ltd.
Heat Treatment and Metallurgy of Tools: **R. Stewart,** Chief Metallurgist, Pratt and Whitney Div., The John Bertram and Sons Co. Ltd.
Special Machine Design and Application: **C. P. Farr,** Chief Engineer, Modern Tool Works Ltd.
Cutting Fluids and Lubrication: **R. Schablitzke,** Manager, Industrial Sales, McColl-Frontenac Oil Co. Ltd.
Tool Design and Application: **J. Harrison,** Assistant Master Mechanic, McKinnon Industries Ltd.
Hobs and Broaching Practice: **F. Schytte,** Colonial Tool Co. Ltd.
Automotive Industry Representative: **J. Dowler,** General Superintendent, Industrial Engineering Div., Ford Motor Co. of Canada Ltd.
Aircraft Industry Representative: **E. Bartle,**

Assistant Master Mechanic, Gas Turbine Div., A. V. Roe Canada Ltd.

**QUALITY CONTROL**

This panel of well-qualified men of diversified interests will answer your questions as to how "Statistical Quality Control", the most dynamic management tool developed in years, can be applied in your plant toward design, tooling, purchasing, production and inspection problems to help you build a quality product with the greatest value at the lowest cost.

Panel Leader:
**J. C. Knapp**, Superintendent, Quality Control, Ford Motor Co. of Canada Ltd.

Panel Secretary:
**C. R. Burdick**, Supervisor, Quality Analysis Dept., Ford Motor Co.

Panel Members:
**D. H. W. Allan**, Assistant Metallurgist, Process Div., The Steel Co. of Canada Ltd.
**Arthur Bender, Jr.**, Quality Control Engineer, Delco-Remy Div., General Motors Corp.
**J. N. Berrettoni**, J. N. Berrettoni and Associates
**J. D. Gardiner**, Assistant Works Manager, Massey-Harris Co. Ltd.
**B. H. Lloyd**, Statistical Analysis Specialist, Canadian Industries Ltd.
**N. G. Meagley**, Manager, Statistical Quality Control, Willys Motors, Inc.

**RECONCILING SMALLER CANADIAN PRODUCTION TO LARGER U.S. PRODUCTION IN AUTOMOTIVE FIELD**

Organization of the motor car industry in Canada with its smaller production when compared with the same industry in the United States has been developed in varying stages over the past 40 years. The selection of machine tools, tooling and arranging plant layout and methods to keep costs competitive while operating under a 10 to 20% comparative volume have created interesting problems.

Canadian content will also be a related item for discussion.

This applies not only to the vehicle manufacturers, but also to the parts manufacturers.

Panel Leader:
**D. C. Gaskin**, President, Studebaker Corp. of Canada Ltd.

Panel Secretary:
**F. R. Hazelton**, Secretary, Canadian Automobile Chamber of Commerce

Panel Members:
**William Eddie**, Assistant to Factory Manager, Chrysler Corp. of Canada Ltd.
**Charles Eder**, Chief inspector, North Plant Operations, General Motors of Canada Ltd.
**W. P. Park**, Manager, Manufacturing Div. Staff Services, Ford Motor Co. of Canada Ltd.
**J. C. Armer**, Vice President, Dominion Forge and Stamping Co. Ltd.
**J. E. Gammage**, Vice President, Sales, Hayes Steel Products Ltd.
**E. H. Walker**, President, McKinnon Industries Ltd.

**SELECTION AND TRAINING OF TECHNICAL AND SUPERVISORY PERSONNEL**

In industry, every organization is interested in the development of management personnel. Therefore, every organization must consider needs for training, selection processes, pre-management training, training for existing supervision and evaluation of training programs.

Panel Leader:
**R. L. McMurray**, General Motors Institute Management Training Representative, McKinnon Industries Ltd.

Panel Secretary:
**O. A. Hanna**, Assistant Personnel Director, McKinnon Industries Ltd.

Panel Members:
**E. R. Complin**, Manager, Industrial Relations, Canadian Industries Ltd.
**O. L. Crissey**, Chairman, Personnel Evaluation Services, General Motors Institute
**R. F. Howsam**, Supervisor of Education, Studebaker Corp. of Canada Ltd.
**H. A. Pilkey**, Manager, Administrative and Factory Training, The Carborundum Co.
**R. M. Robinson**, General Manager, Appliance Div., Canadian General Electric Co.
**Robert Teasdale**, Assistant Personnel Manager, Atlas Steels Ltd.

# TECHNICAL SESSION

## Friday, Oct. 30

**9:30 a.m.** — **Ballroom 2nd Floor**

Welcome—**R. W. Richards**, General Chairman of Meeting

Chairman—**T. N. Beaupre**, Assistant Deputy Minister, Department of Defence Production, Canada

Secretary—**W. E. Corfield**, Department of Defence Production, Canada

**AIRCRAFT PRODUCTION**

**A Plan for Airframe Production**
**D. P. Stowell**, Assistant to President, Canadair Ltd.

Airplane production begins on paper with a master plan coordinating men, machines, management. This paper outlines the plan's basic characteristics, types and sources of necessary data, and the mechanics of assembly and presentation.

**Production Engineering for the Civil Market**
**R. B. McIntyre**, Executive Engineer, The de Havilland Aircraft of Canada Ltd.

World-wide commercial markets may lack the urgency of the military, yet create major engineering problems and can be equally demanding. Serving such markets demands achievement of flexibility in integrating the design engineering and manufacturing phases of the cargo aircraft business.

## PLANT TOURS

**1:30 p.m.**

**Tour 1—A. V. Roe Canada Ltd., Gas Turbine Div. (Bus fare $1.00)**

**Tour 2—Massey-Harris Co. Ltd. (Bus fare 50¢)**

**(Buses leave Royal York Hotel 1:30 P.M.)**

**Please buy your bus tickets early at the SAE Registration Desk.**

## General Reception

**6:15 p.m. to 7:00 p.m.** — **Ballroom 2nd Floor**

SAE Canadian Section—Host

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**7:00 p.m.** — **DINNER** — **Concert Hall 2nd Floor**

**A. A. Scarlett**
Chairman, SAE Canadian Section

Toastmaster—**R. W. Richards,**
General Chairman of Meeting

**Robert Cass**, SAE President

**Principal Speaker**

**REGINALD M. BROPHY**
Deputy Minister, Department of Defence Production, Canada

# SAE National Diesel Engine Meeting

## *The Conrad Hilton, Chicago, Illinois* — *Nov. 3-4, 1953*

### Tuesday, Nov. 3

**9:00 a.m.** **North Ballroom**

Welcome—

**A. F. Ochtman**, General Chairman of Meeting
Chairman—**R. T. Sawyer**, American Locomotive Co.
Secretary—**W. P. Green**, Armour Research Foundation, Illinois Institute of Technology

**Gas Turbine Locomotive Operating Costs and Performance—Both Here and Abroad**
**P. A. McGee**, Consulting Engineer, New York City
The acid test of service endorses or blights expectations. Here are realistic data evaluating the operating performance of six gas turbine locomotives at work in Switzerland, Britain, and the U. S.

**2:00 p.m.** **North Ballroom**
Chairman—**F. G. Shoemaker**, Detroit Diesel Engine Division, General Motors Corp.
Secretary—**Gregory Flynn, Jr.**, Research Laboratories Division, General Motors Corp.

**Scavenging the Two-Stroke Engine—Experience at M.I.T.**
**C. F. Taylor** and **A. R. Rogowski**, Massachusetts Institute of Technology
Round-up of findings during a decade of two-stroke research at M.I.T. Emphasized are the effects of engine design and operation variables on scavenging blower requirements and methods of predicting and measuring scavenging efficiency.

### Wednesday, Nov. 4

**9:30 a.m.** **North Ballroom**
Chairman—**V. C. Young**, Eaton Mfg. Co.
Secretary—**Vincent Ayres**, Eaton Mfg. Co.

**The New Packard Light Weight Diesel Engines**
**Marsden Ware, R. E. Taylor,** and **Julius Witzky**, Packard Motor Car Co.
Packard's new diesel combines light weight, small package life, and long life. Its good performance and versatility adapt this new diesel to a variety of applications.

**Development of an Improved Automotive Diesel Combustion System**
**Bruno Loeffler**, Mack Manufacturing Corp.
A 15% improvement in fuel consumption can offset rising fuel costs and taxes. It becomes possible by analyzing promising combustion designs, finding new applications for old principles, and devising efficient injection equipment.

**2:00 p.m.** **North Ballroom**
Chairman—**J. C. Miller**, Cummins Engine Co., Inc.
Secretary—**M. L. Fast**, Cummins Engine Co., Inc.

**Studies on the Storage Stability of Distillate Fuels. Results of Storage Tests.**
**F. G. Schwartz, C. C. Ward** and **H. M. Smith**, Petroleum Experiment Station, U. S. Bureau of Mines
Take 34 distillates and 60 blends, maintain under six different storage conditions, and test at five intervals. Results reveal the incompatibility of fuels and contaminants, point to fundamental causes of instability.

**Factors Affecting Diesel Exhaust Valve Life**
**J. A. Newton**, Thompson Products, Inc., **J. L. Palmer**, Lubrizol Corp., and **V. C. Reddy**, Detroit Diesel Engine Division, General Motors Corp.
Diesel exhaust valve breakage, assuming annoying proportions, differs from similar troubles with gasoline engines and calls for specialized material development programs. Correlation of failures with designs, materials, and deposits suggests correctives.

### Wednesday, Nov. 4

**Normandie Lounge 2nd Floor** — **Social Half Hour** — **6:15-6:45 p.m.**
SAE Chicago Section—Host

### Joint Dinner

**Diesel Engine Meeting** — **Transportation Meeting**
**Fuels and Lubricants Meeting**

**Grand Ballroom** — **7:00 p.m.**

**M. R. BENNETT**
Chairman, SAE Chicago Section

**ROBERT CASS**
SAE President

Toastmaster—**R. E. WILSON**
Chairman of the Board
Standard Oil Co. (Indiana)

**"Skeptical Strangers or Faithful Friends"**

**J. T. RETTALIATA** President, Illinois Institute of Technology

# SAE National Fuels and Lubricants Meeting

## The Conrad Hilton, Chicago, Illinois — Nov. 4-6, 1953

### Thursday, Nov. 5

**9:00 a.m.** **North Ballroom**

Welcome—

**H. L. Hemmingway**, General Chairman of Meeting

Chairman—**F. E. Selim**, Phillips Petroleum Co.

Secretary—**C. S. Hansen**, Pure Oil Co.

**Chicago Transit Authority Reports on Propane**

**J. N. Jobaris**, Chicago Transit Authority

Two years of operating 550 propane-fueled vehicles 50 million miles fully develop the advantages and disadvantages of propane as fuel. Related data: difficulties with fuel and equipment, solutions for engineering problems, handling recommendations.

**Three Years of City Bus Operation with LPG Fuel**

**J. E. Ebinger**, The Wichita Transportation Corp.

One of the pioneering motor bus operations on bottled gas shows such intriguing results as substantial fuel savings and reduced maintenance costs, plus engines operating for 225,000 miles without rebuilding.

**Making Cent$ with LPG**

**J. H. Powell**, San Antonio Transit Co.

The economic rewards of using gas fuels in motor buses presented in words and pictures. Additional data cover emergency problems, safety precautions, equipment requirements, and the demands of regulatory agencies.

**2:00 p.m.** **North Ballroom**

Chairman—**H. L. Moir**, Pure Oil Co.

Secretary—**F. A. Suess**, Continental Oil Co.

**Forty Years of Progress in Automotive Lubrication—A Look into the Future**

**H. C. Mougey**, Research Laboratories Division, General Motors Corp.

A salute to those who overcame major engineering difficulties to lubricate early automotive equipment. To meet probable future requirements, progress must continue at the same pace or faster.

Discussion Forum to follow paper.

To be presented by title:

**An Electron Microscope Study of the Performance of a Detergent Oil**

**J. B. Peri**, California Research Corp.

The electron microscope's 32,000 x magnifying power discloses correlations between flocculation and deposition in lubricants. With detergent oils, both occur at 40 to 60 hours, indicating the advisable oil-change period.

### Friday, Nov. 6

**9:00 a.m.** **North Ballroom**

Chairman—**J. B. Duckworth**, Standard Oil Co. (Indiana)

Secretary—**H. R. Taliaferro**, Standard Oil Co. (Indiana)

**Compression and End-Gas Temperatures From Iodine Absorption Spectra**

**S. K. Chen**, International Harvester Co., **O. A. Uyehara** and **P. S. Myers**, University of Wisconsin, and **N. J. Beck**, Douglas Aircraft Co., Inc.

Iodine gas, coloring intake mixtures, permits measuring temperatures of unburned charges in spark-ignition engines with acceptable accuracy. Among the findings: Under certain operating conditions, temperatures are higher with 90- than with 50-octane fuel.

**Practical Application of Measured Engine Combustion Temperatures**

**G. H. Millar**, Ford Motor Co., and **O. A. Uyehara** and **P. S. Myers**, University of Wisconsin

To reveal more about fuel consumption, this paper presents data obtained by simultaneously measuring cylinder pressure, volume, and flame temperature, then relating them to such variables as ignition timing and air-fuel ratio.

**Engine Knock as Influenced by Precombustion Reactions**

**J. M. Mason** and **H. E. Hesselberg**, Ethyl Corp.

Laboratory use has been found for fuel knocking tendencies. Extremely sensitive detectors of precombustion reactions, they facilitate study of the influence of fuel types, lead, and engine operating conditions.

**2:00 p.m.** **North Ballroom**

Chairman—**W. G. Ainsley**, Sinclair Research Laboratories, Inc.

Secretary—**Andy Lenz, Jr.**, Sinclair Research Laboratories, Inc.

**Weather or Knock (Road Ratings and Requirements Year-Round)**

**R. I. Potter** and **E. H. Scott**, Standard Oil Co. (Ohio), and **H. J. Gibson** and **G. W. Stanke**, Ethyl Corp.

Motor fuel octane requirements are affected by temperature, pressure, humidity, wind velocity, coolants, thermostats, car makes and models, and geography. This paper organizes data on conflicting factors, presents comparable findings.

**The Cause of Carburetor Gumming**

**H. W. Sigworth** and **J. Q. Payne**, California Research Corp.

Deposits in the throttle body of carburetors cause engines to idle poorly, stall frequently. They stem from crankcase fumes, blowby, and other intake-air contaminants. This paper describes correctives.

**Anti-Knock Requirements of Passenger Cars—1951-1952**

(Report of the Coordinating Research Council)

**H. W. Best**, Yale University, **Leonard Raymond**, Socony-Vacuum Oil Co., Inc., and **R. K. Williams**, Research Laboratories Division, General Motors Corp.

Large-scale cooperative surveys, sponsored by Coordinating Research Council, point ways to determining octane number requirements by analyzing the road behaviorism of nearly 1,000 vehicles. Data cover design, age, engine speed, test fuels, transmissions, and geographical distribution.

# SAE National Transportation Meeting

## The Conrad Hilton, Chicago, Illinois — Nov. 2-4, 1953

### Monday, Nov. 2

**10:00 a.m.** **Upper Tower** 29th Floor

Welcome—

**E. D. Hendrickson**, General Chairman of Meeting

Chairman—**R. C. Wallace**, Diamond T Motor Car Co.

Secretary—**E. A. Comfield**, Diamond T Motor Car Co.

**Motor Coach Suspensions**

**H. E. Fox** and **D. J. LaBelle**, GMC Truck and Coach Div., General Motors Corp.

Enduring human desire to ride a cloud has been reduced to realistic and attainable dimensions by air suspension. The technique has limitations, but also superiorities over preceding practices.

**Steering Arrangements and Ball Suspension Possibilities in Commercial Vehicles**

**J. H. Booth**, Michigan Div., Thompson Products, Inc.

Geometry has encountered few practical jobs tougher than those hiding in steering linkages, and now complicated by power steering. New cures for old headaches are suggested by ball suspension designs and applications.

(Sponsored by Truck and Bus Activity)

**2:00 p.m.** **Upper Tower** 29th Floor

Chairman—**H. L. Willett, Jr.**, The Willett Co.

Secretary—**G. W. Johnson**, Bowman Dairy Co.

**Human Engineering: A New Approach to Driver Efficiency and Transport Safety**

**R. A. McFarland**, School of Public Health, Harvard University

Until recently the driver's job and wel-

fare have received far less engineering attention than the vehicle. Modern idea is that efficient transportation depends upon effective operation. It's good business to make good driving physically possible.
(Sponsored by Transportation and Maintenance Activity)

## Tuesday, Nov. 3

**9:30 a.m.** **Upper Tower** 29th Floor

Chairman—**E. B. Ogden**, Consolidated Freightways, Inc.
Secretary—**L. C. Kibbee**, American Trucking Associations, Inc.

**SYMPOSIUM—Commerical Vehicle Exhaust Noise, Its Cause and Cure Muffler Headaches**
**R. L. Hardgrove**, The Liberty Highway Co.

**Measurement of Truck Exhaust Noise**
**D. B. Callaway**, Armour Research Foundation, Illinois Institute of Technology

**Exhaust Noise and Back Pressure vs. Engine Operation**
**M. L. Fast**, Cummins Engine Co., Inc.

**Truck Manufacturers' Problems in Regard to the Exhaust Noise Reduction Program**
**B. F. Jones**, Autocar Division, The White Motor Co.

**Problems of the Muffler Manufacturer**
**C. E. Nelson**, President, Nelson Muffler Corp.
Plagued by keen-eared public and police, economic pressure and mechanical back-pressure, commercial vehicle operators are calling for help in the way of silent, efficient, and inexpensive mufflers. The problem, noisier and more complicated than Fibber McGee's closet, is kaleidoscopic with physical, engineering, and anatomical enigmas. Samples: What is noise? When is noise too noisy?
(Sponsored by Transportation and Maintenance Activity)

**2:00 p.m.** **Upper Tower** 29th Floor

Chairman—**W. A. Jensen**, Reo Motors, Inc.
Secretary—**H. G. Ingerson, Jr.**, Reo Motors, Inc.

**Easier Driving with Power Steering**
**T. H. Thomas**, Bendix Products Div., Bendix Aviation Corp.
Power steering of commercial vehicles eases strains on driver brain, brawn, and nerves, improves operating techniques—that is, if performance possibilities are understood and realized.

**Greater Payload with Power Steering**
**S. G. Johnson**, International Harvester Co.
Increased payloads result from chassis modifications and better weight distribution when full advantage is taken of the potentialities of power steering. This paper discusses how to gain the advantages without running afoul of weight laws.
(Sponsored by Truck and Bus Activity)

## Wednesday, Nov. 4

**9:30 a.m.** **Upper Tower** 29th Floor

Chairman—**C. A. Lindblom**, International Harvester Co.
Secretary—**Bart Rawson**, Commercial Car Journal

**SYMPOSIUM — The Cab-Over-Engine Chassis for Over-the-Road Operations**

**Some Design Elements for COE Highway Tractors**
**F. S. Baster** and **C. H. Fager**, The White Motor Co.

**COE Highway Tractors—Design Problems and Solutions**
**F. R. Nail**, Mack Manufacturing Corp.

**The Need for Dimensional and Operating Characteristics of COE Chassis**
**L. C. Kibbee**, American Trucking Associations, Inc.

**Fleet Maintenance Characteristics of COE Tractors and Trucks**
**L. E. Kassebaum**, Consolidated Freightways, Inc.
Operators want big payloads, driver comfort and convenience. Engines and accessories occupy space, and the laws limit motor truck length, width, and weight. Result, an engineering problem with picture-puzzle twists. Every thing must fit into place. The assembly must function with mechanical and economic efficiency. Some engineers believe putting the cab over the engine may be the solution.
(Sponsored by Truck and Bus Activity)

**2:00 p.m.** **Upper Tower** 29th Floor

Chairman—**O. A. Brouer**, Swift and Co.
Secretary—**A. W. Neumann**, The Willett Co.

**Motor Truck Electrical Equipment**
**J. H. Bolles**, Delco-Remy Div., General Motors Corp.
Swinging to motor vehicle electrical systems, the automotive engineering spotlight polarizes 6-, 12-, and 24-volt choices. Need is for understanding and evaluation of progress in generators, starters, ignition systems, and the rest.
(Sponsored by Transportation and Maintenance Activity)

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# YOU'LL . . .

## . . . be interested to know that . . .

RENAMED as SAE directors on the Board of Coordinating Research Council are E. N. Cole, G. J. Huebner, Jr., R. D. Kelly, and Arthur Nutt. Their two-year terms will expire Dec. 31, 1955. SAE members on the board whose terms end Dec. 31, 1954, are L. L. Bower, W. G. Lundquist, and E. S. MacPherson.

* * *

SAE WILL PARTICIPATE in one of the annual railroad conferences of the National Railway Lubrication Conference, through papers to be sponsored by the SAE Fuels and Lubricants Activity. Other participants will be the American Petroleum Institute, the American Society for Testing Materials, and the American Society of Lubricating Engineers.

* * *

SYMPOSIUM ON HELICOPTER FATIGUE, co-sponsored by the American Helicopter Society, will be a feature of the SAE 1954 Annual Meeting in Detroit.

* * *

SAE WILL JOIN other engineering societies in co-sponsoring the Heavy Press and Air Cargo programs during the ASME Annual Meeting, Nov. 30–Dec. 4, 1953. These programs, participated in by the SAE Air Transport, Aircraft, Aircraft Powerplant, and Production Activities, will be an extension of, and similar to, the programs co-sponsored by SAE at the 1952 Annual and 1953 Semi-Annual Meetings of the ASME.

* * *

NEWEST SAE STUDENT BRANCH, approved by Council in September, is at the University of Missouri School of Mines and Metallurgy in Rolla, Mo. This brings to 49 the number of SAE Student Branches.

# MANUFACTURING MEN . . .

## . . . to gather at SAE International Production Meeting in Toronto later this month.

FOR the second time this year SAE is holding an international meeting in Canada. The SAE International West Coast Meeting was held in Vancouver in August. This month, on October 29 and 30, the SAE International Production Meeting will convene in Toronto, at the Royal York Hotel.

Under the general chairmanship of R. W. "Dick" Richards, the forthcoming Meeting features a combination of elements which serves up information the way manufacturing men like it. As in previous successful SAE production meetings, this one offers an amalgamation of a day of Production Forum panels, technical papers, and plant inspection trips. The technical program was developed by Col. Malcolm P. Jolley, who is also general chairman of the Production Forum.

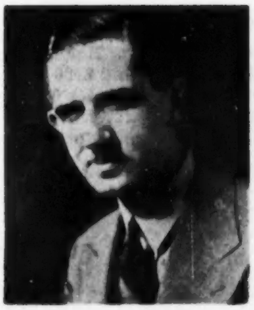
Col. Jolley and his group designed panel subjects and member composition to attract and serve production men in both the United States and Canada. (See the program on pages 78 and 79.) In selecting panel members, Jolley and his associates have, been successful in getting the services of specialists from both sides of the border.

Principal speaker at the dinner on Thursday, October 29, will be Reginald M. Brophy, Deputy Minister, Department of Defence Production, Canada. Arrangements have been made to visit the A. V. Roe and Massey-Harris plants on the afternoon of Friday, October 30.

General Chairman of Production Meeting

R. W. Richards

General Chairman of Production Forum



Malcolm P. Jolley

# BOTTS' . . .

## . . . creator, W. H. Upson, to speak again at 1954 Annual Meeting dinner, Jan. 13, at Detroit.

WILLIAM Hazlett Upson is going to speak following the dinner on the Wednesday evening of SAE Annual Meeting week, Jan. 11-15. He is author of the Alexander Botts stories in the Saturday Evening Post and a former service representative for Caterpillar.

Those who attended the Annual Meeting dinner in 1948 will remember Upson's talk on Ergophobia, the fear of work. In it, he explained how as a traveling trouble shooter he spent his days repairing tractors and instructing operators and his evenings writing reports to the home office. He found that the more he wrote, the less work he had to do and the more money he made. Finally, so his story went, he stopped working altogether and concentrated on writing. The results include his stories of the exploits of Alexander Botts, fabulous salesman for the Earthworm Tractor Co., and many other published articles.

William Hazlett Upson

Between lecture engagements and visits back with cronies in the tractor business, Upson lives in Middlebury, Vermont. He's a member of the Middlebury Rotary Club and a former member of the Village Board of Trustees.

# STUDENTS . . .

## . . . can transfer directly to SAE membership. Council eliminates extra enrollment year.

TRANSITION of SAE enrolled students to membership was facilitated by action of SAE Council last month. First year dues for all graduating enrolled students were established at $10 and, as in the past, the initiation fee is being waived. The alternate provision of continuing enrollment for a year following graduation has been discontinued to bring the students more quickly into the Society and provide them with the fuller benefits of membership.

The SAE Student Committee feels that this move will encourage enrolled students to apply for membership prior to, or at the time of, graduation. In this way the graduate, as he enters upon his professional career, can partake of the complete services offered to the members by the Society rather than being restricted to the limited services available to enrolled students. As a member, he can participate in local SAE Sections, and receive upon request the SAE Handbook and SAE Roster as well as notices of national and local meetings.

To be eligible for transition to SAE membership on this basis, the applicant must have paid at least one full year's student enrollment fee.

# SAE Section Meetings

### Buffalo—Oct. 8

A. O. Smith Corp., Rochester. Dinner 6:30 p.m., meeting 8:00 p.m. Plant tour through A. O. Smith plant (Joint Buffalo and Rochester meeting.) A. J. Ristow, divisional general manager, A. O. Smith Corp.

### Canadian—Oct. 29

Royal York Hotel, Toronto. Dinner 7:00 p.m. Reginald M. Brophy, deputy minister, Department of Defense Production, Ottawa. This is the Section dinner to be held in conjunction with the International Production Forum.

### Central Illinois—Oct. 19

Allis-Chalmers Mfg Co., Springfield, Ill. Dinner 6:30 p.m., meeting 7:45 p.m. Preventative Maintenance—F. S. Wimberley, service training, Allis-Chalmers Mfg. Co.

### Chicago—Oct. 13

Hotel Knickerbocker, Chicago. Dinner 6:45 p.m., meeting 8:00 p.m. The Chevrolet Corvette—Maurice Olley, director of research and development, Chevrolet Division, GMC. Social half-hour 6:15 to 6:45 p.m.

### Cleveland—Oct. 12

Lake Shore Country Club. Dinner 6:30 p.m., meeting 8:00 p.m. Power Brakes—Walter Nichols, chief experimental engineer, and E. R. Fitzgerald, chief engineer, Power Brake Division, Midland Steel Products Co. Several test cars (Fords) will be on display, all equipped with these power brakes.

**Correction**

Baltimore Section's secretary was omitted from the list of 1953-54 SAE Section officers which began on page 104 in the August, 1953 issue. He is Emory B. Kaufman, manager, K&G Sales Co.

### Colorado—Oct. 22

Petroleum Club. Dinner 6:30 p.m., meeting 7:30 p.m. The 12-volt Electrical Systems — Herman Hartzell, vice-president in charge of engineering, Delco-Remy Division, GMC.

### Detroit—Oct. 19 and 26

Oct. 19—Small Auditorium, Rackham Educational Memorial Bldg. Meeting 8:00 p.m. Power Takes Over the Wheel—Dennis J. Hayman, Gemmer Mfg. Co.; Joseph R. Farnham, Chrysler Corp.; Thomas D. Kosier, Ford Motor Co. Consultants: H. C. Parsons, Vickers, Inc.; C. W. Lincoln, Saginaw Steering Gear Division, GMC; C. J. Smith, Monroe Auto Equipment Co. Moderator: Ernest DeFusco, Research Laboratories Division, GMC. Social hour in the Snack Grille following the meeting.

Oct. 26—Small Auditorium, Rackham Educational Memorial Bldg. Meeting 8:00 p.m. The Multifarious Military Truck—H. D. Duppstadt, civilian chief, Development and Proof Services, Transport Vehicle Section, Aberdeen Proving Ground. Movie—"Sun, Sand and Steel."

### Hawaii—Oct. 12 and 15

Oct. 12—Kewalo Inn, Honolulu. Dinner meeting. Engineering Frontiers—1953 SAE President Robert Cass.

Oct. 15—Hilo, Lanai. Dinner meeting. Engineering Frontiers—1953 SAE President Robert Cass.

### Indiana—Oct. 8

Marott Hotel. Dinner 7:00 p.m., meeting 8:00 p.m. Tire Safety at High Speed—M. P. Hershey, Firestone Tire and Rubber Co.

### Metropolitan—Oct. 15 and 21

Oct. 15—Brass Rail Restaurant, 5th Ave. at 43rd St. Dinner 6:30 p.m., meeting 7:45 p.m. Fuels and Lubricants. \$3.00—members and \$4.00—nonmembers.

Oct. 21—Activity Meeting 7:45 p.m. Garden City Hotel, Long Island, N. Y.

### Milwaukee—Nov. 6

A meeting to be held at Milwaukee Athletic Club.

### Mohawk-Hudson—Oct. 13

Circle Inn, Latham, N. Y. Dinner 6:30 p.m., meeting 8:00 p.m. Development of the Turbo Compound Engine—W. R. Eichberg, Wright Aeronautical Division, Curtiss-Wright Corp. Talk illustrated with slides.

### New England—Oct. 8 and Nov. 5

Oct. 8—Meeting will be held at the Faculty Club, M.I.T., Cambridge, Mass.

Nov. 5—Meeting will be held at the Faculty Club, M.I.T., Cambridge, Mass.

### Philadelphia—Oct. 14

Engineer's Club. Dinner 6:30 p.m., meeting 7:45 p.m. Moving Toward Adequate Roads—Roy E. Jorgensen, engineering counsel, National Highway Users' Conference.

### Pittsburgh—Oct. 27

Joint ASTM and SAE meeting. General Talk on Additives—L. C. Beard, Jr.

### St. Louis—Oct. 13

Gatesworth Hotel. The 12-Volt Story—H. L. Hartzell, assistant chief engineer, Delco-Remy Division, GMC.

### Salt Lake City—Oct. 12

Newhouse Hotel, Meeting 8:00 p.m. The Diesel Engine Demands Fuel—E. A. Desmond, Ethyl Corp.

### Southern Calif.—Oct. 15 and Nov. 12

Oct. 15—Rodger Young Auditorium, Los Angeles. Dinner 6:30 p.m., meeting 8:00 p.m. Auto Racing—Modern Style—Ray Crawford, owner-driver; Clay Smith, mechanic; Bob Estes, car

sponsor. Motion pictures of 1952 Mexican Pan American Road Race.

Nov. 12—Rodger Young Auditorium. The Future Turbine-Type Commercial Transport—H. E. Hoben, director, Aircraft Analysis, American Airlines. W C. Lawrence, director, Development Engineering, American Airlines, Inc.

### Southern New England—Nov. 4

Hartford Golf Club. Titanium and Related Post-War Alloys—Heinrich Adenstedt, chief metallurgist, Lycoming-Spencer Division, Avco Mfg. Corp.

### Spokane-Intermountain—Oct. 20

Caravan Inn. Dinner 7:15 p.m., meeting to follow. Movie—"Diesel Tractors." Caterpillar Tractor Co., Spokane, Wash.

### Texas Gulf Coast—Oct. 9

Ye Old College Inn, Varsity Room, Houston, Texas. Dinner 6:00 p.m., meeting 7:45 p.m. Training Today's Engineers for Tomorrow's Jobs—Howard W. Barlow, dean of engineering, Texas A. & M. College.

### Twin City—Oct. 14

Curtis Hotel. Dinner 6:30 p.m., meeting 8:00 p.m. Traffic Signs and Signals—Allan Johnson, head, auto electric department, Dunwoody Institute, Minneapolis.

### Virginia—Oct. 26

William Byrd Hotel, Westover Room. Dinner 7:00 p.m. Power Steering—I. N. Schatzka, Monroe Auto Equipment Co. Social Hour 6:30 p.m.

### Washington—Oct. 29

Demonstration at Quantico Marine Base of air ground activity.

### Wichita—Oct. 21

Droll's English Grill. Dinner 6:30 p.m., meeting 7:30 p.m. Development of the Beech Model 50 Airplane—M. J. Gordon, Chief of Aerodynamics, Beech Aircraft Corp., H. D. Barnett, project engineer, Beech Aircraft Corp., will speak on the same subject.

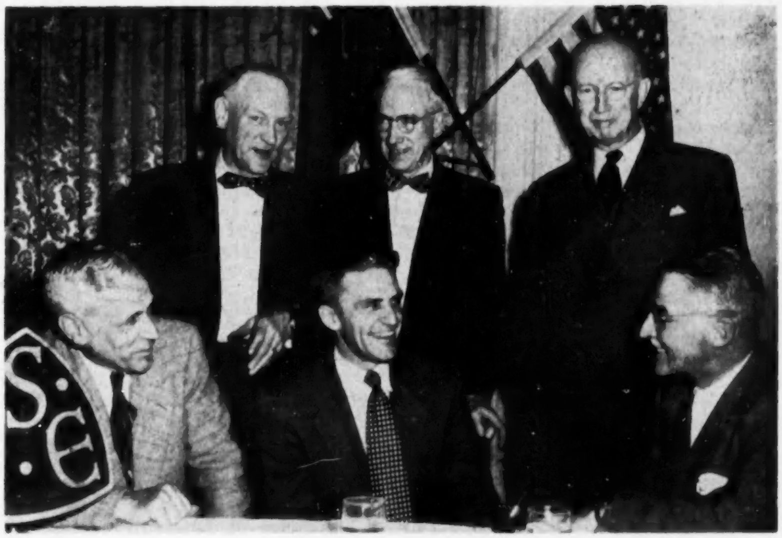
### Williamsport—Nov. 2

Antler's Country Club. Dinner 6:45 p.m., meeting 8:00 p.m. Heavy-Duty Engines—J. E. Glidewell, chief engineer, Hall Scott Motor Division, ACF Brill Motors Co.

# SAE Section News

## British Columbia Officers Assume Duties

E. C. "Ted" Howell, transportation superintendent, Evans, Coleman & Evans Ltd., and retiring chairman of the British Columbia Section, presents the Section's gavel to incoming chairman Alan B. Reid, truck sales manager for Wolfe Chevrolet Oldsmobile Ltd.



Back row left to right: L. B. McPherson, Truck Parts & Equipment Ltd., vice-chairman transportation and maintenance; Burdette Trout, Truck Parts & Equipment Ltd., secretary; James B. Mortimer, recenty retired from the motor coach mechanical staff of the British Columbia Electric Railway Co., treasurer.

Newly elected officers are: (front row left to right) Herb Welsh, Lawson Oates Motors, vice-chairman; C. Willis, Home Oil Distributors, vice-chairman fuels and lubricants; Alan B. Reid, chairman.

Detroit Section Chairman Kenneth E. Coppock (left) and SAE Vice-president for Body Activity, H. E. Chesebrough, (right) talk with Dorothy Liebes, leading fabric designer, about some of the new designs Mrs. Liebes had just described at the technical session the opening day of the Detroit Section Summer Meeting. Chesebrough was chairman of the session

# Detroit

TECHNICAL sessions on design of fabrics and design of race cars highlighted Detroit Section's Summer Meeting at White Sulphur Springs, Sept. 11-13. Golf, sports, amusements and sociability were, as usual, prominent features as well.

More than 300 Detroit Section members and their wives made up the attendance at this most successful event, developed under the general chairmanship of T. W. Flood. Others involved with Flood in organization of the meeting and its special program were L. L. Beltz (Transportation); E. P. Lamb (Social Events); B. E. Ricks (Golf); Mrs. H. B. Orr (Ladies Golf) and Mrs. E. S. Witchger (Bridge and Canasta).

H. E. Chesebrough, who is currently SAE Vice President for Body Activity, was chairman of the Friday technical session. There Dorothy Liebes, described as "America's First Lady of Textiles," told how fabrics are designed and showed glittering samples of varied and beautiful fabrics typical of those likely to be popular during the coming seasons.

Chairman Chesebrough opened the session by pointing out that automobile fabric designs usually follow those used in house furnishings with a lag of several years in between. He closed it —after viewing the striking designs displayed by Mrs. Liebes—by predicting some very startling developments in automobile upholstery in the next few years.

Mrs. Liebes said the function of fabric design is two-fold: (1) to make a fabric which will serve usefully, and (2) to make one which will give maximum pleasure to the senses.

People do respond to what they are familiar with, she admitted. But, she contended, they also respond to what is really good—provided manufacturers give it to them, show it to them, and make them familiar with it. Given a choice, she said, the public will choose the best.

People react most strongly to color in fabrics, she said, but also to texture and design. She told of movements in which manufacturers of all different kinds of home furnishings agree on use of a single pallet of colors for a given year. Thus the buyer gets good matches or contrasts in buying different items of house furnishings in different places at different times.

The Saturday technical sessions, under the chairmanship of P. H. Pretz, centered around talks given by guest speakers Maurice Rose, three times a winner of the Indianapolis race, and Z. Arkus-Duntov, well-known European race driver and designer.

Rose explained the strategy used by American race track drivers. He gave details on the technique of approaching and negotiating dangerous turns at various speeds and emphasized the important factor of timing.

Equally vital, according to Rose, is that elusive instinct known as "driving by the seat of one's pants." He emphasized the psychological factors and told of the outwardly stoical driver with "butterflies in his stomach," and of the superstitions from which no driver is free and which an alert opponent can use to put a rival off-balance.

He mentioned improvements made

T. W. Flood was general chairman for this year's Detroit Section Summer Meeting at White Sulphur Springs

# Section at White Sulphur Springs

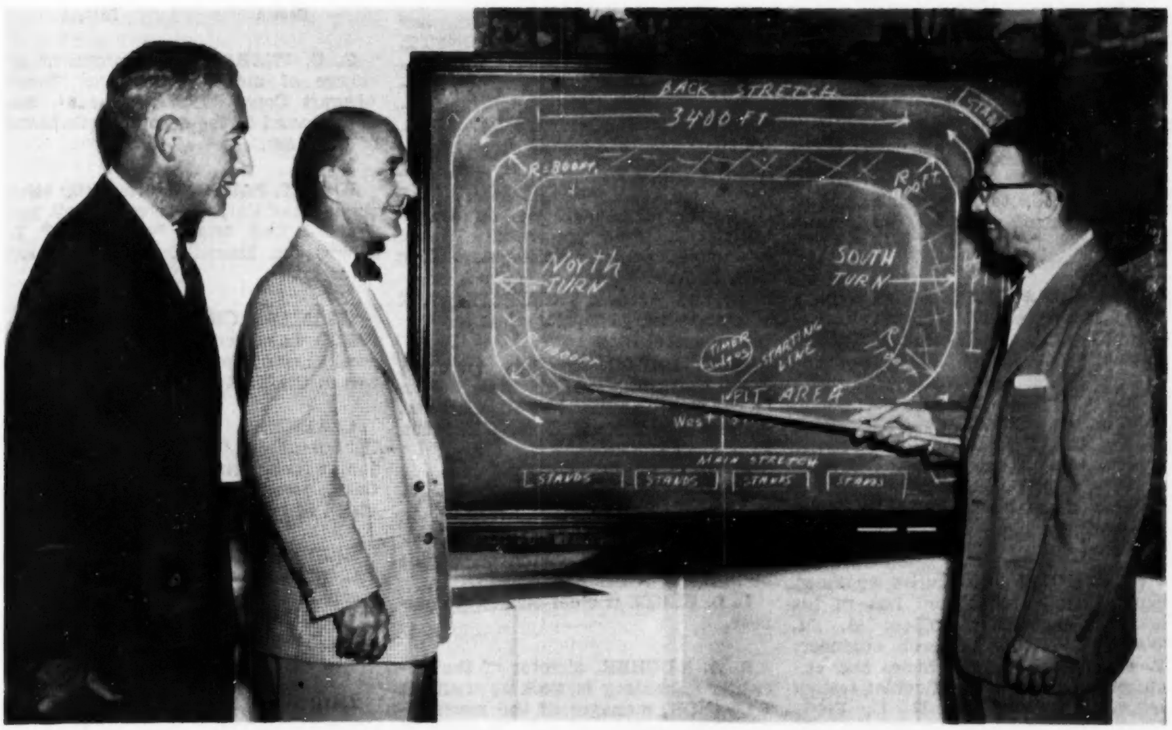
on the Indianapolis track, especially the safety apron and retaining walls, and covered the aspects of speed qualification trials and the technical trends which have evolved from track experience. Some accessories and instruments, once thought indispensable, were found to be a possible hazard and were almost completely eliminated from some designs.

From the early racing days when gasoline was the usual fuel, he said, we arrived at pure methane or alcohol, with the latest addition being a percentage of nitro-methane. New fuels and the contribution made by the development of high-speed tires are mainly responsible for increasing our speeds in the last few years, Rose said.

Z. Arkus-Duntov spoke about the evolution of the race car in Europe. He said that until 1906 the European racing car had almost no similarity to the passenger car. The European Automobile Association decided to reduce this gap. Engine displacement was limited and the results were streamlining to attain higher speeds and the evolution of better transmissions for low-speed flexibility and performance.

The Le Mans 24-hr Race in France, or any road race, (contrary to the man-made track race such as the one at Indianapolis) must allow for a great variety in road contours—hills and sharp turns—requiring extraordinary speed variations. Brakes, therefore, are of utmost importance. He said the main reason why the Le Mans 24-hr Race was won in '53 by a Jaguar was a new disc-type brake which is equivalent to an addition of 50 hp to the engine.

Duntov suggested that European drivers don't suffer much from nervous tension, that is Rose's "butterflies in the stomach," because there are no official qualifying trials which, he thought, are largely responsible for the anxiety of American drivers.




Maurice Rose (right), three-time winner of the Indianapolis Race, and Z. Arkus-Duntov, long prominent in European racing before coming permanently to United States, were speakers at the second day's technical session on "Technical Aspects of Racing." Philip H. Pretz (center), a past chairman of Detroit Section, was chairman of the session

# About SAE

**BURT C. MONESMITH**, vice-president and general manager of Lockheed Aircraft's California Division, dedicated the company's 25,000th airplane, a Starfire or F-94C. Ceremonies were held at the final assembly plant for jets at Van Nuys, Aug. 20. Monesmith was the 1953 sponsor and 1952 general chairman of SAE's Aircraft Production Forum in Los Angeles.


Monesmith


Darsie

**BURNS DARSIE** has been appointed chief engineer of Dixon Research, Inc., Rockford, Ill. Darsie was engineer for Roy S. Sanford & Co., Oakville, Conn.

**M. E. CUSHMAN**, formerly chief development engineer at Curtiss-Wright Corp.'s Propeller Division, Caldwell, N. J., is now chief engineer for Marvel Mfg. Co., Caldwell, N. J.

**WILLIAM J. McCLURE** is with Modern Machinery Co., Inc., Seattle, as a sales engineer. He was with Fageol Motors, Inc., Seattle, as a salesman.

**RALPH S. DAMON**, president of Trans World Airlines, Inc., New York, was honored as "National Management Man" by the National Association of Foremen, Sept. 25, at the association's thirtieth annual convention in Milwaukee. He was cited "for furthering the ideals and philosophy of the N. A. F."


Damon


Pearson

**C. C. PEARSON**, vice-president in charge of manufacturing for Beech Aircraft Corp., Wichita, Kansas, has been elected to the corporation's board of directors.

**JOHN T. PARSONS**, previously vice-president of Parsons Corp., Detroit and Traverse City, Mich., has joined F. L. Jacobs Co., Danville, Ill., as division manager.

**THOMAS CHRISTIAN GREENFIELD** has been elected to the vice presidency of Tom Greenfield, Inc. He was in the U. S. Air Force.

**CLARKE F. CAREY**, previously a lieutenant in the U. S. Navy, is a junior tool engineer in the Richmond, Calif., assembly plant in the Ford Division of Ford Motor Co.

**ELBERT BRUNNER REYNOLDS, JR.**, previously assistant professor of mechanical engineering, Pennsylvania State College, is now researeh assistant, mechanical engineering department, University of Wisconsin.

**GORDON H. MILLAR**, formerly project engineer, Ethyl Corp., Research Labs, Detroit, is now research engineer in the scientific laboratory of Ford Motor Co., Dearborn, Mich.

## Ford Engineering Staff Changes

Many SAE members have new or revised responsibilities in the organization of the Ford Motor Co. engineering staff announced by vice-president **EARLE S. MacPHERSON**, as effective August 1, 1953.

Reporting directly to MacPherson are six executive engineers (one of whom remains to be appointed) and the director of the scientific laboratory.

**V. Y. TALLBERG** is executive engineer, administration, and has in his administrative engineering office the following: **C. L. BOUCHARD**, manager, building and facilities department; **A. E. VALLIER, JR.**, manager, experimental fabricating department; **H. D. ALLEE**, manager, engineering programming department; **J. A. CATTO**, manager, administrative services department; **R. G. EVANS**, purchasing agent.

**R. F. KOHR** is executive engineer, general engineering, and has in his general engineering office: **A. M. WAUTERS**, chief research engineer; **P. H. PRETZ**, chief vehicles test engineer; **H. H. GILBERT**, chief testing laboratories engineer; **H. G. ENGLISH**, chief transmission engineer; **W. K. BURTON**, chief service engineer.

**H. A. MATTHIAS**, executive engineer, passenger vehicles design, has working under him: **W. E. BURNETT**, chief Ford car engineer; **H. C. MacDONALD**, chief advanced vehicles engineer; **N. L. BLUME**, chief Lincoln-Mercury car engineer; **J. A. LINE**, manager, overseas engineering department.

The executive engineer, commercial vehicles, is to be appointed. In the commercial vehicles engineering office is **F. E. SANDBERG**, chief truck engineer, and **A. A. PARQUETTE**, chief special military vehicles engineer.

**H. C. GREBE**, executive engineer, body engineering office, has in his office: **C. L. WATERHOUSE**, manager, styling department; **C. F. KRAMER**, chief body engineer.

**V. G. RAVIOLO**, executive engineer, engines, has reporting to him: **R. STEVENSON**, chief engine engineer and **E. ZOERLEIN**, manager, engine build-up activities department.

**L. L. BELTZ** is chief electrical engineer.

**A. A. KUCHER**, director of the scientific laboratory is working with: **P. KLOTSCH**, manager of the mechanical department; **F. A. KLEMACH**, manager, special projects department.

# Members...

**WALTER ROCKWELL** sailed for Europe early in October for a two-month stay in Southern France and Italy. Mrs. Rockwell is accompanying him. He has resigned as president of Timken-Detroit Axle Co.

**RAYMOND O. HAHN** has been appointed Cincinnati branch manager for Highway Trailer Co., Edgerton, Wis. Hahn was previously a salesman for Highway Trailer.

**RONALD WATSON** has joined General Motors Corp., Detroit, as test engineer in the power development section. Watson was previously a student at California Institute of Technology.

**GORDON CHRISTY**, formerly West Coast sales engineer for Wright Aeronautical Corp., Division of Curtiss-Wright Corp., Los Angeles, has returned to Wood-Ridge, N. J., to become assistant manager of the Sales Engineering Division of Wright Aeronautical.

**MAYNARD B. TERRY** has been elected vice-president of American Brake Shoe Co.'s subsidiary, Dominion Brake Shoe Co. Terry is also president of the American Brakeblok Division of the company.

Terry

Collins

**WHITNEY COLLINS** has been appointed chief engineer of Continental Aviation & Engineering Corp.'s recently-formed Gas Turbine Division, Detroit. He has been project manager, gas turbine engines, at Continental since 1951.

**EDWARD V. RICKENBACKER** has become chairman of the board of Eastern Airlines. Formerly president of Eastern, Rickenbacker will continue as general manager and chief executive officer.

Rickenbacker

Wells

**EDWARD C. WELLS**, vice-president of engineering, Boeing Airplane Co., Seattle, has been appointed to head a newly-formed Boeing planning committee. At the same time, Wells' responsibilities have been redefined to emphasize research and development work and to include an analysis of customer requirements as a basis for future planning. He will give general policy direction to both engineering and sales functions.

**LAURENCE M. BALL** has been appointed chief laboratories engineer in the missile branch of Chrysler Corp.'s Engineering Division. He has been supervising engineer in the sound and vibration laboratories, which he established, since 1943.

**THOMAS PATRICK SIMPSON** has joined General Petroleum Corp., Los Angeles, as assistant director of manufacturing. He was previously director of the research and development department, Socony-Vacuum Oil Co., Paulsboro, N. J.

**LAURIE C. SMITH** has joined Marquart Aircraft Co., Van Nuys, Calif., as engineer. He was previously inspection officer for the Bureau of Ships, USN, located at Fairbanks, Morse & Co., Beloit, Wis.

**HAROLD G. VAUGHAN** has been elected president of the Muskegon Piston Ring Co., Sparta, Mich. Vaughan has been first vice-president of Muskegon since 1936.

Vaughan

Doss

**RAYMOND O. DOSS** has been appointed production manager of Fisher Body Division's (GMC) plant No. 2 in Grand Rapids. Doss has been senior engineer in charge of general projects in Fisher's central engineering activities. He is SAE chairman of Body Activity for 1954.

**CLIFFORD R. ROGERS** has become chief engineer of special products for The Oliver Corp. in Chicago. He was previously plant manager of the Aviation Division of Oliver, Battle Creek, Mich.

**EDGARD C. DeSMET**, formerly director of body engineering of Willys Motors, Inc., Toledo, has been appointed executive engineer of Kaiser Motors Corp., Willow Run, Mich. He will serve as a member of the executive staff of the Research and Development Engineering Division.

DeSmet

Laubin

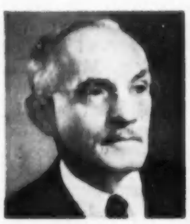
**C. WILLIAM LAUBIN** has joined Nagler Helicopter Co. as chief design engineer. A member of SAE's Aircraft Powerplant Activity, Laubin was formerly senior staff engineer of Command Helicopter Corp.

**ROBERT M. RAMEY** is now with AiResearch Mfg. Co., Los Angeles, as a development engineering associate. He was previously chief of the artillery ammunition department, Frankford Arsenal, Philadelphia.

McCreery Anderson

**FRANK E. McCREERY** and **G. FRED ANDERSON** won recent promotions with the Rohr Aircraft Corp. of Chula Vista and Riverside, Calif. McCreery, formerly executive chief engineer, advanced to the status of vice-president, engineering. Anderson, previously department head of the weights and structures group, is now chief project engineer of the Riverside plant.

**DR. GUSTAV EGLOFF**, director of research, Universal Oil Products Co., Chicago, has been named national director of the Armed Forces Chemical Association for 1953-54, as well as a member of the association's advisory committee, Midwest Chapter. He has also been appointed a member of the Washington Award Commission of the Western Award Commission, Western Society of Engineers for 1953-1956, and is one of four honorary fellows not British subjects who were elected to the Royal Society of Edinburgh for 1953.



Egloff

Spicer

**DONALD H. SPICER**, formerly vice-president of manufacturers' sales for American Bosch Corp., Springfield, Mass., is now vice-president in charge of general sales activities.

**CHRISTIAN L. JENSEN** is now service manager for Berl Berry Motor Co., Kansas City, Mo. Jensen was with Safety Motors, Inc., Chicago, as service manager.

**CHARLES R. PEARSON** is engineering designer for Temco Aircraft Corp., Dallas. Pearson was with Boeing Airplane Co., Seattle, as an engineering designer "A".

**DAVID E. MORRIS**, previously assistant service manager, Atlanta zone, for Nash Motors, Atlanta, is now district manager for the same company.

**FRED C. RUNFOLA** is vehicle program coordinator with the Department of the Air Force, top staff level, located at Warner Robins Air Materiel Area, Robins Air Force Base, near Macon, Ga. He is responsible directly to the commanding general.

**S. C. MASSARI**, manager of the Foundry Division, Hansell-Elcock Co., Chicago, will be chairman of the discussion panel on modern foundry management techniques during the 25th anniversary meeting of The Gray Iron Founders' Society, Inc. The meeting will be held in St. Louis, Oct. 8 and 9. **T. W. CURRY**, director of manufacturing research, Lynchburg Foundry Co., Lynchburg, Va., will also be on the panel, and **FRANCIS L. FLETCHER**, partner of Alderson & Sessions, Philadelphia, will be a speaker.

**FRED B. LEE**, civil aeronautics administrator, Washington, D. C., **HECTOR J. ALEXANDER**, special representative, A. E. Ulmann & Associates, New York, and **THOMAS Z. FAGAN**, advertising manager, Scintilla Magneto Division, Bendix Aviation Corp., Sidney, N. Y., will be on the Advisory Board of the International Aviation Trade Show to be held next May in New York City. They will help formulate policy for the show and arrange supplementary programs.

**ROLLAND L. ANDERSON** has joined Champion Spark Plug Co., Toledo, as service manager in the aviation department. Anderson was director of engineering for Chicago & Southern Airlines, Inc., at the Municipal Airport, Memphis, Tenn.

**JOHN E. BRENNAN** has been appointed to the executive staff, Dodge Division, Chrysler Corp., Detroit. His new assignment will be in addition to his present duties as general manager of the Chrysler jet engine plant at Utica, and his administrative responsibility for defense activities at the Dodge San Leandro (Calif.) plant will be extended to include civilian activities as well.

Brennan

McCaslin

**HENRY C. McCASLIN** has been appointed director of manufacturing-engineering for Willys Motors, Inc., and its new Kaiser-Willys Sales Division. He will coordinate operations in the recently combined divisions of Willys and Kaiser Motors.

**CALVIN B. HUNTOON** is now with Shell Oil Co. in Indianapolis as industrial products manager. He was previously assistant lubricants manager for Shell.

**PAUL I. WILTERDINK**, formerly aeronautical research scientist, NACA Lewis Flight Propulsion Lab., Cleveland, is with Phillips Petroleum Co. in Bartlesville, Okla.

## Dana Corp. Appointments

Burkhalter

Mazziotti

Carter

**R. R. BURKHALTER** has been promoted to the new position of assistant executive engineer of the Dana Corp., Toledo, Ohio. He was chief engineer for the Universal Joint Division, Spicer Mfg. Division, Dana Corp. **PHILIP MAZZIOTTI**, previously Universal Joint engineer, takes over Burkhalter's former position and **ROBERT CARTER**, who was project engineer, is now in Mazziotti's previous position.

Heins

Buske

**EDWARD D. HEINS** has been appointed chief engineer for the Export Division of Chrysler Corp., Detroit. Heins was previously a staff engineer in the Export Division.

**GILBERT BUSKE,** former chief engineer for the National Pressure Cooker Co., Eau Claire, Wis., has been named engine development engineer in the Lawn Mower Division of Reo Motors, Inc., Lansing, Mich.

**RALPH E. WILLIAMS** is now assistant works manager for De Laval Separator Co., Poughkeepsie, N. Y. He was previously director of purchases for National Pneumatic Co., Inc., Boston.

**C. ALLAN BRADY** has been named chief liaison engineer in the missile branch of Chrysler Corp.'s Engineering Division. Since 1950 he has been staff assistant in the special products planning department of the corporation.

Spase

Root

**C. B. SPASE,** former chief engineer, Clutch Division, Lipe-Rollway Corp., Syracuse, has been made chief engineer of automotive development, responsible for all automotive research. He is chairman of SAE's Syracuse Section. **ROBERT S. ROOT,** assistant chief engineer, succeeds Spase as chief engineer, Clutch Division.

**EUGENE F. WARD** is now with Consolidated Freightways, Inc., in Los Angeles as a shop foreman. He was with Coast Line Truck Service in Los Angeles as a shop foreman.

**WILLIAM E. BATES** has been appointed chief blade design engineer in charge of the Blade Design Section at Curtiss-Wright Propeller Division's new Propeller Engineering Section. Bates was formerly blade design engineer in the same division.

## Named by Ford

**DALE ROEDER** has been named chief engineer of the Ford Tractor Division of Ford Motor Co. A past-president of SAE, Roeder has been on the Ford Motor Co. engineering staff for many years, most recently as executive engineer for commercial vehicles. His new post puts him in charge of the engineering operations of Ford Tractor Division, the result of Dearborn Motors becoming a division of Ford. The Tractor Division will have its own completely integrated engineering operations, separate from those of Ford Motor Co.'s engineering staff, to handle farm tractors and farm equipment.

**A. R. ROGOWSKI,** associate professor of mechanical engineering at M.I.T., is the author of a new textbook on internal-combustion engines. It is designed to give the basic theory in a one-term course to engineering students, even though they never expect to enter the engine field professionally. Emphasis is placed on the application of the elementary principles of physics, chemistry, mechanics, and the like, to the specific engineering problems connected with estimating and obtaining the maximum power, efficiency, and reliability from engines. The book, "Elements of Internal-Combustion Engines," contains 234 pages, 116 illustrations, and is published by McGraw-Hill, New York, for $5.50.

**FRED E. WILSON** is with the Southern Division of The Borden Co., Houston, as director of transportation. He was superintendent of transportation for the Houston Lighting & Power Co.

**P. M. HELDT** has brought his well-known volume, "High-Speed Diesel Engines," up to date. The text of this new seventh edition has been completely revised and new illustrations have been added. For example, several new governing devices are described and the chapter on 2-stroke engines now includes charts giving expressions for the shaking forces and rocking couples in 2-stroke engines with different numbers of cylinders and different crank arrangements. Publisher is P. M. Heldt, Nyack, N. Y.

**HAROLD J. HARVEY** is now with the Glenn L. Martin Co., Baltimore, as a structures engineer. Harvey was previously with the Kaiser-Frazer Corp., Willow Run, Mich.

**ERIC D. BONOW** is with Ansul Chemical Co., Marinette, Wis., as design engineer. Bonow was formerly technical assistant for Nordberg Mfg. Co.

## Young Inaugurates New Program

**F. M. YOUNG,** president, Young Radiator Co., (left) inaugurates a new expansion program at his company's Mattoon, Illinois plant. Between Young and Contractor Francis Farrier appears the cornerstone of the new development which was christened at ground-breaking ceremonies last June.

## Open House at Burgess-Norton

Many SAE members, including the chairman of the Chicago Section, were among the visitors at Burgess-Norton Mfg. Co.'s open house session, Aug. 20, during the company's 50th anniversary celebrations.

Front center: **Frank K. Burgess.** First row, left to right: **Keith Evans, G. B. Kiner, C. M. Burgess,** president of Burgess-Norton; **Clarence Hubert, Harold Parsley, A. E. Rosenbloom, Harry Land.** Standing: **P. L. Houser, M. R. Bennett,** chairman of the Chicago Section; **W. R. Dalenberg,** vice-chairman of the Tractors, Industrial Power and Diesel Engines Activity in the Chicago Section; **E. H. Middendorf, Henry A. Ferguson, J. W. Curley, C. B. Johnson,** vice-president of sales, Burgess-Norton.

**ARCH T. COLWELL,** staff vice-president, engineering, research and development, Thompson Products, Inc., Cleveland, has announced that Thompson was awarded a contract by the Bureau of Aeronautics, U. S. Navy, to build and operate a jet engine test facility to be located in Perry Township, Ohio. Colwell said Thompson has no intention of developing its own jet engine. "Our objective is to perfect the old components and develop the new to keep ahead of ever-increasing performance that is now required."

**DONALD F. SUPPES** has joined Files Steam Specialty Co., Boston, as sales manager. Suppes was field engineer with Aero Engineering, Inc., Mineola, N. Y.

**EDGAR G. GRAY** is general-manager for Distribuidora Anglo-Colombiana, Ltda., Bogota, Colombia. Gray was formerly overseas representative for Nuffield Exports Ltd., Cowley, Oxford, England.

**WEICHIEN CHOW** has become project engineer for Sparton Automotive Division, Sparks-Withington Co., Jackson, Mich. He was research associate at the University of Wisconsin.

## Students Enter Industry

**JOHN P. PIZZAGALLI** (University of Miami '53) is president and owner of American Decors, Westmount, Quebec, Canada. Pizzagalli, who was in partnership for two years, recently purchased the company outright. The company is the exclusive plastic plant distributor in Canada for Plastic Plants of Cleveland, Inc.

**JOHN D. NOCK, JR.** (North Carolina State College '54) is plant superintendent for Becker County Sand & Gravel Co., Camden, S. C.

**JOHN B. STEWART** (University of Colorado '52) is a technical assistant at Massachusetts Institute of Technology.

**STANLEY A. LORING, JR.** (Parks College of Aeronautical Technology '53) has become a design engineer in the missiles engineering department of McDonnell Aircraft Corp. in St. Louis, Mo.

**HAROLD E. BEEGLE** (Pennsylvania State College '53) has been employed by Lukens Steel Co., Coatesville, Pa., as technical assistant to the superintendent of the machine, forge and grind shops.

**DONALD A. MALOHN** (Tri-State College '52) has joined the Studebaker Corp., South Bend, as assistant foreman in charge of the calculating department, jet engine testing.

**ALFRED THATE, JR.** (University of Wisconsin '53) is with the Square D Co., Milwaukee, as an application engineer.

**ROBERT N. KENNEDY** (Southern Methodist University '53) is a research assistant for the University of California.

**THOMAS E. LAMBERT** (University of Michigan '53) has joined Ingersoll-Rand Co. as a student engineer.

**JAMES F. HAYES** (Yale University '53) is a sales engineer for The Trane Co., La Crosse, Wis.

**JOHN F. VIZZINI** (Academy of Aeronautics '49) is a pilot in the U. S. Air Force.

**JAMES C. EMANUEL** (Bradley University '53) is at Aberdeen Proving Ground, Aberdeen, Md., as a project engineer.

**STEPHEN PALISKA** (Princeton University '53) is with the Hamilton Standard Division of United Aircraft Corp., Windsor Locks, Conn. He is a sales engineer.

**LOUIS R. LATCH** (Southern Methodist University '53) has joined the Consolidated Vultee Aircraft Corp., San Diego, as a test engineer.

**MICHAEL BERKEY** (General Motors Institute '53) is a junior engineer in the Detroit Transmission Division of GMC, Livonia, Mich.

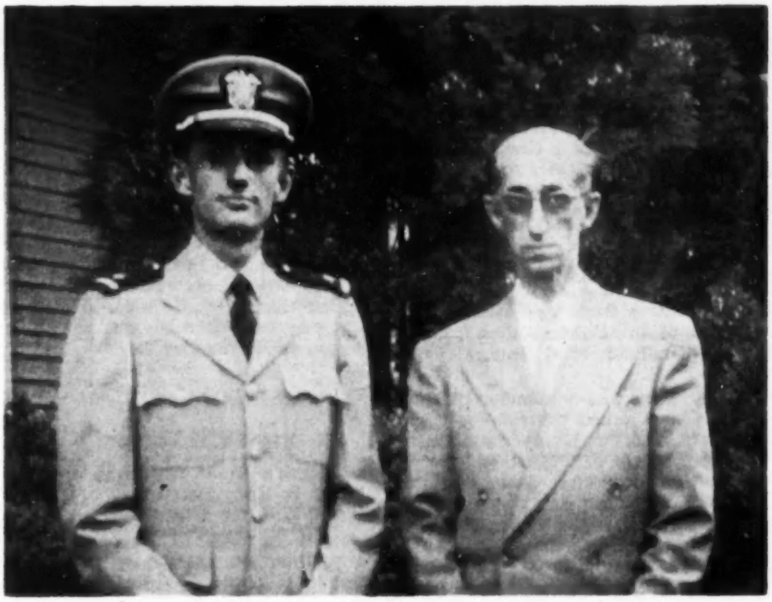
**EARLE H. STEPP** (Chrysler Institute of Engineering '53) is a laboratory engineer for Chrysler.

**JOHN P. ULLRICH, JR.** (Syracuse University '53) is a research engineer in the Eclipse Machine Division of Bendix Aviation Corp., Elmira Hts., New York.

**HERBERT V. BAAK, JR.** (California State Polytechnic College '53) is in the experimental test department, Hall-Scott Motor Division, ACF-Brill Motors Co., Berkeley, Calif.

Continued on Page 100

# SAE Fathers and Sons...



**GEORGE C. CROMER** (left) is the son of **ORVILLE C. CROMER** (right), associate professor of mechanical engineering at Purdue, faculty adviser for Purdue's SAE Student Branch and student chairman of the Indiana Section.

George, who received his B.S. degree in mechanical engineering from Purdue last May, is now an ensign serving as assistant engineer officer on a destroyer. Upon completion of his period of active service he plans to resume work with Chrysler where he was a student engineer.

Cromer senior has made the SAE Student Branch at Purdue an outstanding campus activity year after year.

**ARTHUR HERRINGTON, JR.,** (left) graduate student at M.I.T., and **ARTHUR HERRINGTON, SR.,** SAE president in '42 and a member of the Society for many years, are the latest father and son combination. The younger Herrington is studying chemical engineering.

Past-president Herrington is one of the founders of Marmon-Herrington Co., Inc., Indianapolis, and has been a member of SAE's Ordnance Advisory Committee, the Military Motor Transport Advisory Committee and the Membership Committee. He was chairman of the Indiana Section for 1934-35, as well as '33 chairman of the Motorcoach & Motor Truck Division of the Standards Committee. He has also presented many technical papers before Society meetings.

# Obituaries

### LOUIS M. KLINEDINST

Louis M. Klinedinst, former vice-president in charge of sales and a director of the Timken Roller Bearing Co., Canton, Ohio, died August 10, of a heart ailment. He was 70.

Beginning as an assistant superintendent with Timken in 1905, when it employed no more than 60 persons, he worked his way through various positions as an assistant chief inspector, production manager, service supervisor and manager of the tractor and farm implement department. He organized and developed the industrial sales division for the Timken Co.

After his retirement in 1948, Klinedinst was retained as a director and sales consultant for Timken and also became active in civic work, heading YMCA, Cancer and Red Cross drives. He had a particular interest in physically disabled persons and their placement in industry.

He was a member of the Society of Military Engineers, the Army Ordnance Association, the Iron and Steel Electrical Engineers, the Automotive Old Timers Club, as well as SAE. Some of the other organizations to which he belonged were The Detroit Athletic Club, Congress Lake Club and Brookside Country Club. He was a 32nd degree Mason, a member of the Scottish Rite Bodies and of the Tadmor Shrine in Akron.

### MAGNUS M. BURGESS

Magnus M. Burgess, president of Sheller Mfg. Corp., Portland, Ind., and devoted benefit worker for orphaned and unfortunate boys, died August 14. He was 56.

President and chairman of the board for Sheller, Burgess began work for that company in 1929 as general manager. Previously he had been treasurer and general manager of the Murray Corp. of America, a merger of C. R. Wilson Body Co., the Murray Body Corp. and two other firms. He had entered industry with C. R. Wilson Body Co. in 1910.

In Detroit he is remembered for his work in behalf of unfortunate youngsters. He was chairman of the Recess Club where he instituted a plan to sell out Briggs Stadium in Detroit. Business executives bought seats in large numbers which they sold in their companies and which were given to orphanages. Over $30,000 worth of tickets were bought at the first meeting and Burgess's plan is still continued.

A Baptist himself, he was chairman of a group of Detroiters who made a success of the Boys Town-Catholic Central football game, a game to obtain money for youths at Boys Town, Nebr., and for the building fund of a new Catholic Central High School. The school has since been erected.

His memberships, besides SAE, included the Recess, Detroit Athletic and Oakland Hills Country Clubs. He was president of the latter organization for several years.

### GEORGE L. KELLEY

George L. Kelley, deputy chairman of the Pressed Steel Co., Ltd., manufacturers of automobile bodies, Cowley, Oxford, England, died July 25. He was 74.

Kelley, who was a member of SAE for 31 years, joined the Society when he was a metallurgist at the Edward G. Budd Mfg. Co., Philadelphia. He was author of "Sheet Steel and the All-Steel Body," a paper presented before SAE's annual meeting in 1930 and published in the February '30 Journal. He went to England in '31 and became factory manager for the Pressed Steel Co. Prior to his association with Budd, he had been chief chemist for Midvale Steel & Ordnance Co.

A native of Massachusetts, Kelley received the Bachelor of Science degree in chemistry, magna cum laude, from Harvard University where he later received his Doctor of Philosophy degree.

He held memberships in many organizations other than SAE which included the American Chemical Society, the Franklin Institute and the American Society for Testing Materials.

### JOHN J. SHERIDAN

John J. Sheridan, flight inspector for the Department of the Navy, Bureau of Aeronautics, at Lockheed Aircraft Co., in Burbank, Calif., died July 8. He was 66.

An SAE member for almost 30 years, Sheridan joined the Society when he was working at the Los Angeles Branch of Rolls Royce of America, Inc. A first-class mechanic with many years of practical experience, he held various positions at Rolls Royce including tester, inspector and service manager.

He was born in Dundalk, Ireland, where he attended the Christian Brothers' School and specialized in mathematics. He became a naturalized citizen of the United States in 1918 and was in the U. S. Army Aviation Service, from 1917-1919, overhauling aero-engines. Prior to that he was with the Great Northern Railway Works, Dundalk, as an apprentice machinist and fitter.

### J. M. MORROW

J. M. Morrow, 58, vice-president in charge of sales for The Dayton Steel Foundry Co., Dayton, died August 11. He had been with the company since 1927.

A native of Decatur, Alabama, Morrow entered industry in 1915 as a steel melter with the Anniston Steel Co., Anniston, Ala. He had also worked for Standard Steel Castings Co., Interstate Foundries and Mathews Steel Castings Co., all in Chicago. He was foundry superintendent for the latter two companies, and later became a sales engineer when he was with The Dayton Steel Foundry Co.

### EDGAR LEE ELDER

Edgar Lee Elder, 52, owner of Elder Trailer & Body Service, Denver, died August 17, after a brief illness.

Before he organized his own company, Elder was assistant plant superintendent for the Winter-Weiss Co., Denver, builders of truck and trailer bodies. For a three-year period during World War II, he supervised the building of approximately two thousand trailers of different types at Winter-Weiss for the U. S. government. His plant was among the first twenty to receive the Army-Navy "E" award.

Described as a "modest, capable" man, Elder was born in St. Louis. He was raised and received his education at Laddonia, Mo., and went to Denver in 1921. In addition to SAE, he was a member of the Sertoma Club and the Denver Chamber of Commerce.

His survivors are: Helen, his wife; Alan, his son; Mrs. Cloris Turre, his daughter; Guy E. Sr., a brother; and Mrs. Mary E. Major, a sister.

### FRANK W. SQUIRE

Frank W. Squire, vice-president of the Implement Trade Journal Co., Kansas City, Mo., died early in July. He would have been 72 in August.

Squire, who had an interest in tractor development for many years, joined the Implement Trade Journal Co. as an editor's assistant in 1909. Two years later he was an advertising salesman for the Farm Implement News doing reporting and writing as well.

Although he joined the Chilton Co.'s advertising department in 1918, he later rejoined Farm Implement News as the advertising manager and in '46 he became vice-president of the Implement Trade Journal Co.

# TECHNICAL COMMITTEE *Progress*

## Tests Specified for $\frac{1}{4}$-In. Grade 5 Bolts Are Adequate, Div. XXIX Study Indicates

EDITED BY **A. S. Jameson,**

Chairman of ISTC Division XXIX—Bolts, Nuts, and Fasteners; and Supervisor of Metallurgical Research Laboratories, International Harvester Co.

TESTS have shown the adequacy of the requirements outlined for ¼-in. SAE Grade 5 bolts in the SAE Standard on Physical Requirements for Bolts, Capscrews, Studs, and Nuts.

Division XXIX—Bolts, Nuts, and Fasteners supervised the tests, as part of its program of gathering information on tensile properties of SAE bolts. (Division XXIX is a subgroup of the SAE Iron and Steel Technical Committee.) The cooperative tests were made by the Caterpillar Tractor Co.; Deere & Co.; General Motors Corp.'s Detroit Diesel Engine, Electromotive, and Truck & Coach Division; International Harvester Co.'s Manufacturing Research Department; and Russell, Burdsall & Ward Bolt & Nut Co. laboratories of ¼ × 2½-in. SAE Grade 5 hexagon head bolts in the coarse and fine thread series.

Earlier work done for Division XXIX and reported in the October 1951 SAE Journal on pages 57-61 showed that the requirements specified for ½ × 2½-in. Grade 5 bolts were adequate. (SAE Journal carried reports of other Division XXIX research in the November 1951 issue, pages 54-59, and in the September 1952 issue, pages 80-81.)

The tensile tests on the ¼-in. SAE Grade 5 bolts were made at various hardness levels. The effect of the gage length (threads exposed) on the recorded properties was also studied. The bolts were loaded axially, and non-axially by inserting a 10-deg wedge under the bolt head. With axial loading, the yield strength, tensile strength, and total elongation were determined. With the 10-deg loading, only the tensile strength was recorded.

### Test Material

The bolts were made from one heat of SAE 1038 steel of the following analysis: carbon, 0.38%; manganese, 0.76%; silicon, 0.12%. Residual nickel and chromium were less than 0.10%, and molybdenum was less than 0.06%.

The austenitic grain size as determined at 1700 F was SAE No. 5. The bolts were heat-treated by quenching in oil from 1550 F and tempering from 675 to 1060 F to produce eight hardness levels from 41 to 18 Rc. The minimum hardness limit for SAE Grade 5 bolts (up to ¾ in. in diameter inclusive) is 23 Rc. The as-quenched hardness of bolts was not

Table 1—Recorded Hardness and Spread for Each Group

| Code | Spread: Individual Readings, Rc units | Spread: Bolt Readings, Rc units | [a]Code Hardness: Individual Readings, Rc units | [a]Code Hardness: Bolt Readings, Rc units |
|---|---|---|---|---|
| A | 8 | 5 | 19 | 18 |
| B | 8 | 6 | 23 | 23 |
| C | 8 | 6 | 26 | 27 |
| D | 8 | 6 | 30 | 30 |
| E | 9 | 7 | 32 | 31 |
| F | 7 | 6 | 35 | 35 |
| G | 7 | 6 | 38 | 38 |
| H | 6 | 5 | 41 | 41 |
| I | 10 | 7 | 19 | 19 |
| J | 9 | 7 | 23 | 24 |
| K | 9 | 6 | 26 | 27 |
| L | 8 | 6 | 29 | 29 |
| M | 7 | 5 | 32 | 32 |
| N | 8 | 5 | 35 | 35 |
| O | 8 | 6 | 37 | 37 |
| P | 7 | 5 | 41 | 41 |

[a] Based on modes.

Table 2—Average Elongation with Axial Loading for ¼ × 2½ in. Bolts

| Coarse Threads: Hardness, Rc (mode) | Coarse Threads: Elongation, (in.) | Fine Threads: Hardness, Rc (mode) | Fine Threads: Elongation, (in.) |
|---|---|---|---|
| 19 | 0.098 | 19 | 0.095 |
| 23 | 0.093 | 23 | 0.086 |
| 26 | 0.085 | 26 | 0.081 |
| 30 | 0.077 | 29 | 0.071 |
| 32 | 0.071 | 32 | 0.063 |
| 35 | 0.062 | 35 | 0.046 |
| 38 | 0.048 | 37 | 0.042 |
| 41 | 0.029 | 41 | 0.025 |

Table 3—Effect of Gage Length (Exposed Threads) on Elongation Values for ¼ × 2½ in. Bolts

| No. of Exposed Threads | Elongation, in. (Average) Coarse Threads | Fine Threads |
|---|---|---|
| 0 | 0.027 | 0.054 |
| 1 | 0.038 | 0.044 |
| 2 | 0.035 | 0.056 |
| 3 | 0.050 | 0.060 |
| 4 | 0.060 | 0.060 |
| 5 | 0.067 | 0.075 |
| 6 | 0.072 | 0.079 |
| 7 | 0.073 | 0.083 |
| 8 | 0.077 | 0.082 |
| 9 | 0.081 | 0.086 |
| 10 | 0.085 | 0.085 |
| 11 | 0.087 | 0.089 |
| 12 | 0.095 | 0.097 |

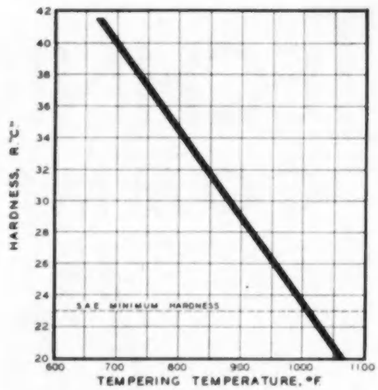



Fig. 1—Tempering curve for ¼-in. bolts made of SAE 1038 steel

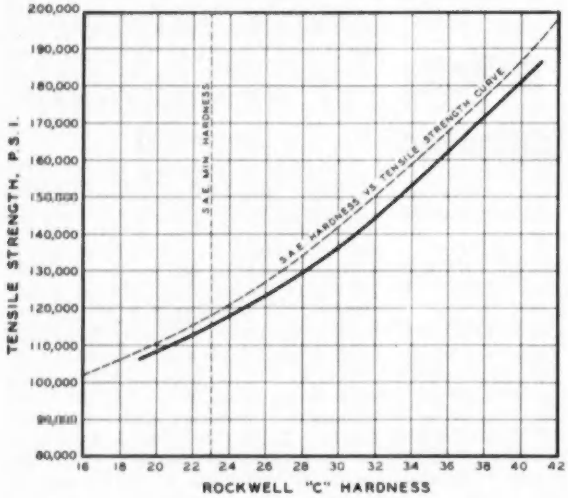



Fig. 2—Tensile strength in wedge loading of ¼-in. coarse thread bolts at various hardness levels

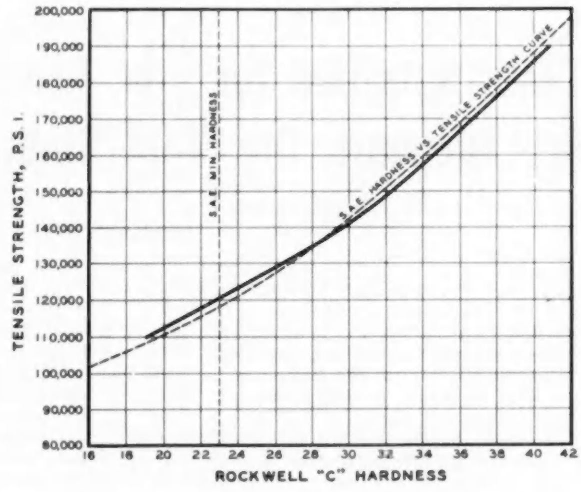



Fig. 3—Tensile strength in wedge loading of ¼-in. fine thread bolts at various hardness levels

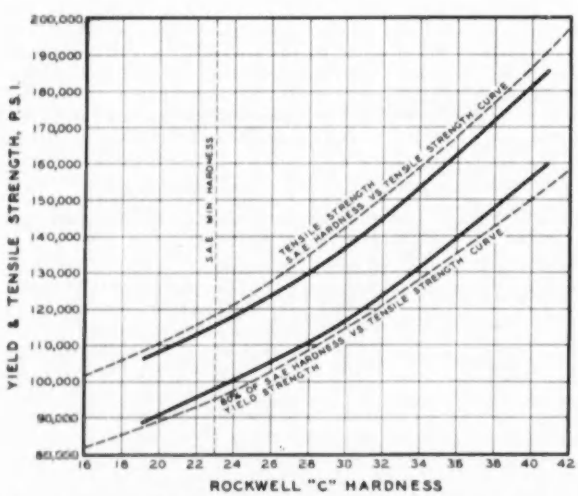



Fig. 4—Yield and tensile strength in axial loading of ¼-in. coarse thread bolts at various hardness levels

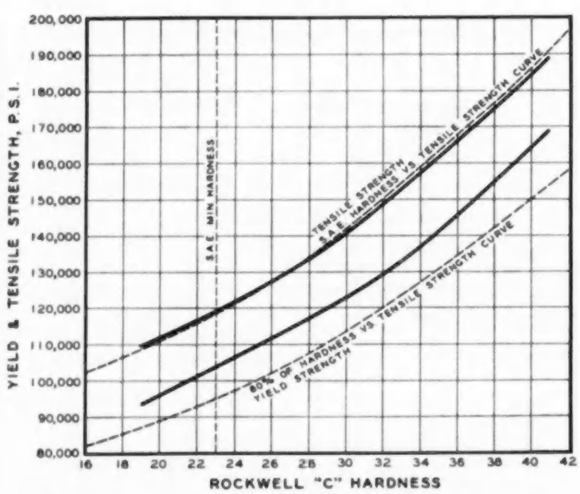



Fig. 5—Yield and tensile strength in axial loading of ¼-in. fine thread bolts at various hardness levels

less than 45 Rc at the center of the threaded section, which represents a more-than-50% martensitic structure. A tempering curve is shown in Fig. 1.

### Hardness

The hardness of each of the eight groups was determined by each laboratory by taking four Rockwell C readings at a location ¼ in. from the threaded end of the bolt at half radius in accordance with practice recommended in the SAE Standard on Physical Requirements for Bolts, Cap-Screws, Studs, and Nuts. The hardness was recorded to the nearest whole number. These readings, approximately 600 for each group, are summarized in Table 1. The group hardness used to relate the tensile properties was the mode of the individual readings. A "bolt reading" as shown in Table 1 is the average of four readings on a bolt.

The spread in hardness on "individual readings" and "bolt readings" appears somewhat wide. This seemed to be due to differences in laboratories rather than a variation in the hardness of the material. For one laboratory the "individual reading" spread for the groups ranged from 4 to 7 points and for "bolt readings" 3 to 4 points.

### Tensile Properties

The psi values used in presenting the tensile data were calculated using a stress area taken from the actual pitch and root diameters of the bolts according to the formula:

$$A = 3.1416 \left(\frac{P+R}{4}\right)^2$$

Here **A** is equivalent area (stress area), **P** is pitch diameter, and **R** is root diameter. These areas were 0.0301 sq in. for the coarse thread and 0.0346 sq in. for the fine thread bolts.

These areas differ from those shown in the SAE Handbook. Ordinarily on a larger diameter bolt, a slight difference in the bolt thread dimensions would be of little significance but in the case of smaller bolts a significant difference is shown where bolts are less than the mean dimensions for the pitch and root. The gage length (exposed threads) was six threads.

The elongation values shown are those taken from load-elongation curves. Elongations measured by other means are not reported, except in Table 3.

The tensile strength using 10-deg wedge loading is shown in Figs. 2 and 3 and the tensile strength of axially loaded bolts in Figs. 4 and 5. These figures include a hardness versus tensile strength curve taken from data contained in the SAE General Information Report on "Hardness Tests and Hardness Number Conversions," Table 4, and in Figs. 4 and 5 a curve for yield strength representing 80% of the hardness versus tensile strength curve. It will be noted that the tensile strengths of the coarse thread bolts, Figs. 2 and 4, fall slightly below this theoretical curve.

Incidentally, the tensile strength of the wedge-loaded bolts was approximately the same as that for the axially loaded bolts. In no case was the difference greater than 1%. The yield strengths were well above the minimum specified proof load of 85,000 psi at 23 Rc. The yield strength of axially loaded bolts as shown in Figs. 4 and 5 was higher for the fine thread bolts. The elongation values for axially loaded bolts are shown in Table 2. The elongation values for the coarse

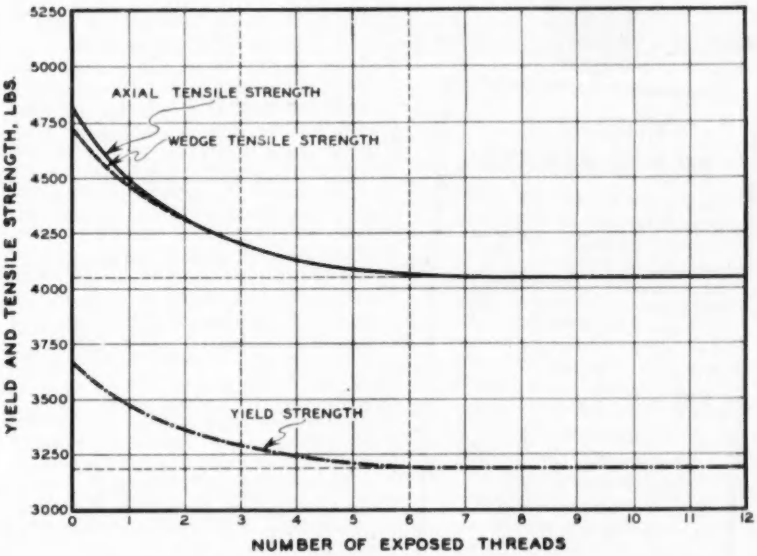



Fig. 6—Effect of gage length (exposed threads) on the recorded yield and tensile values of ¼-in. coarse thread bolts

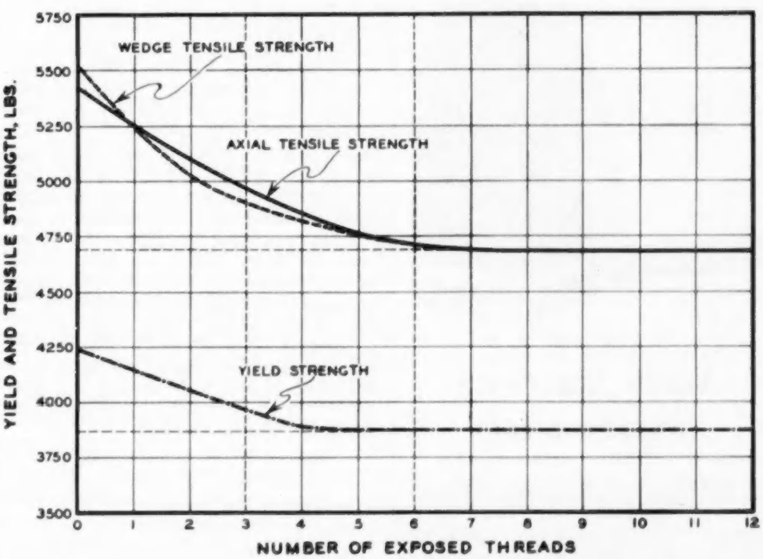



Fig. 7—Effect of gage length (exposed threads) on the recorded yield and tensile values of ¼-in. fine thread bolts

thread series were slightly higher than those for the fine thread series. This would be caused by the slightly greater gage length of the coarse thread bolts. Elongation values are not absolute values as the recorded elongation is affected by the change in the bolt size, body diameter, the number of exposed threads, the number of threads per inch, and the relationship of the length of the threaded section to the length of the unthreaded body.

#### Effect of Gage Length

Data on the effect of thread exposures from 0 to 12 are shown in Figs. 6 and 7 and Table 3 at a hardness level of 28-29 Rc. Elongation data in Table 3 were obtained by joining together broken bolts. It will be seen from Figs. 6 and 7 that the yield and tensile strength are artificially raised with shorter gage lengths (less than six threads exposed) and that the elongation values increase as the number of exposed threads increases. The rate of increase in elongation is relatively small at gage lengths of more than five exposed threads. Where zero threads are shown, it should be understood that some threads are always unengaged in the nut or threaded fixture.

Additional data were also obtained on the effect of exposed threads by duplicating the tensile testing using a three-thread gage length. These data are not reported. The data however were analyzed, and it was found that a three-thread gage length gave tensile values about 2% higher for the coarse thread bolts and about 3% higher for the fine thread bolts.

The difference between the fine and coarse threads may be accounted for by the shorter gage length of the fine thread bolts. There was no difference in the yield strength for coarse and fine threads. The yield strengths were about 2½% higher when three threads was the gage length.

There was an average decrease in elongation using the three-thread gage length of about 25% for the coarse threads and about 20% for the fine threads. Elongation is not a specified value in the SAE Standard, the wedge test being designed to set ductility limits. However, from an engineering standpoint, knowledge of the elongation values for a given bolt may be important. That is because in certain assemblies plastic movement is required in order to compensate for misalignments on bolted members.

These tests show that in commercial practice the Standard's requirements for ¼ in. SAE Grade 5 bolts are adequate. Two questions, however, are raised by this test series:

1. Is it desirable to base stress areas on the minimum root and pitch diameters rather than on the mean pitch and root diameters?

2. Would it be desirable to use a longer gage length, perhaps six threads instead of three threads, in

order to eliminate possible errors in tensile testing due to a variation in thread exposure? With longer gage lengths, variations in testing are minimized.

## Aero Materials Specs Reviewed by Industry

DRAFTS of fifteen SAE Aeronautical Materials Specifications are currently being circulated to industry for comment and criticism by the SAE Aeronautical Materials Specifications Division. Eleven specifications have been approved recently by the SAE Technical Board. Copies of all of these specifications are available for review from the SAE Aeronautical Department.

The specifications under review are:

- AMS 3315B—Silicone Rubber Sheet, Glass Fabric Reinforced
- AMS —— —Fabric, Glass (112) (Decorative Grade)
- AMS —— —Fabric, Glass (120) (Decorative Grade)
- AMS —— —Fabric, Glass (128) (Decorative Grade)
- AMS —— —Fabric, Glass (143) (Decorative Grade)
- AMS —— —Fabric, Glass (162) (Decorative Grade)
- AMS 3835A—Fabric, Glass (181) (Decorative Grade)
- AMS 3836A—Fabric, Glass (182) (Decorative Grade)
- AMS 5382C—Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Cobalt Base, 25.5Cr-10.5Ni-7.5W
- AMS —— —Steel, 1.95Ni-1.15Cr-0.45Mo-0.55Si
- AMS 5525—Steel Sheet and Strip, Corrosion and Heat Resistant, 15Cr-26Ni-1.3Mo-1.9Ti-0.3V
- AMS 5529—Steel Sheet and Strip, Corrosion Resistant, 17Cr-7Ni 1Al, Precipitation Hardening, (200,000 psi Tensile Strength)
- AMS 5733A—Steel, Corrosion and Heat Resistant, 13.5Cr-26Ni 3Mo-1.8Ti
- AMS 7488—Rings, Flash Welded, Aluminum and Aluminum Alloys
- AMS 7498—Rings, Flash Welded, Titanium and Titanium Alloys

The approved specifications are:

- AMS 3087C—Compound, Insulating and Sealing
- AMS 3170B—Thinner, Alcohol—Ester
- AMS 3641A—Plastic Moldings, Thermosetting
- AMS 4756—Solder
- AMS 5053B—Steel Tubing, Welded, Low Carbon, Annealed
- AMS 5352—Steel Castings, Precision Investment, Corrosion Resistant
- AMS 5361B—Steel Castings, Sand and Centrifugal, Corrosion and Heat Resistant
- AMS 5528—Steel Sheet and Strip, Corrosion Resistant
- AMS 5615B—Steel, Corrosion and Moderate Heat Resistant
- AMS 5647—Steel, Corrosion and Heat Resistant
- AMS 6351—Steel, Sheet and Strip

## Bibliography on "Packaging" Can Be Yours

A BIBLIOGRAPHY on shock and vibration as it pertains to packaging of sensitive aeronautic equipment is yours for the asking! Prepared by a subcommittee of SAE Committee S-8, Aircraft Equipment Shock and Vibration Isolation, single copies of this work may be obtained free from SAE Headquarters. (If more than one copy is desired, quantity rates will be charged.)

This 9-page tabulation of sources of information on "packaging" shock and vibration is one of the products of S-8's program (1) to gather basic shock and vibration information, and (2) to study current packaging test procedures and equipment.

As a result of this work, S-8 hopes to come up with better packaging methods to protect aircraft instrument and electronic equipment while in transit.

To achieve these objectives, the committee is channeling its work toward:

- Division of all instruments, electronic gear, and similar fragile items into groups based on fragility.
- Determination of shock and vibration testing procedures that will permit such ratings to be made.
- Development of simple formulas, nomographs, and other procedures for determining proper amount and type of packaging for equipment so rated.

Bendix Radio Division's J. H. Best is chairman of this SAE Special Aircraft Projects Division committee.

## Students Enter Industry

Continued from Page 92

**HOWELL C. LOWE** (Cornell University '53) is in the engineering department of the J. I. Case Co., Racine, Wis.

**GEORGE F. REITMEIER, JR.**, (Rensselaer Polytechnic Institute '53) is an assistant research engineer for the Cornell Aeronautical Lab., Inc., Buffalo.

**JOSEPH D. LENGYEL** (University of Pittsburgh) is with E. I. Du Pont de Nemours and Co. in Charlestown, Ind., as shift engineer.

**WILLIAM PETER GILLES** (Loyola University '53) has joined Douglas Aircraft Co., Inc., El Segundo, Calif., as a liaison engineer.

**CALVIN G. ESTES** (Wayne University '53) is now with the engineering department, dynamometer section, of Ford Motor Co., Dearborn, Mich.

**HAROLD M. WIES** (Case Institute of Technology '53) is a quality control engineer for The Hoover Co., North Canton, Ohio.

**ROY EHNHUUS** (College of the City of New York '53) is a student engineer in the manufacturing training program, Hyatt Bearings Division, GMC, Harrison, N. J.

**JOSEPH J. MILIANO** (Northeastern University '53) is in the engineering department of the Boston, Mass., Edison Co.

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**JOSEPH F. MACURA** (General Motors Institute '53) is on the engineering staff of GMC, Detroit, as a junior engineer.

**MALCOLM C. MacCLEOD** (Academy of Aeronautics '53) is an instructor at the Casey Jones School of Aeronautics, Inc., Farmingdale, New York.

**FREDERICK B. WIGGINS** (Chrysler Institute of Engineering '53) is a development engineer for Chrysler in Detroit.

**THOMAS J. FEAHENY** (University of Detroit '53) is in training at the Detroit Transmission Division of GMC, Livonia, Mich.

**BENNIE SHULTZ, JR.** (University of Oklahoma '53) is a test engineer for the General Electric Co. in Cincinnati. He is in the Aircraft Gas Turbine Division.

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**REINHOLD H. HOLLINGER** (University of Massachusetts '53) is a development test engineer at United Aircraft

Continued on Page 101

## Students Enter Industry

continued

Corp.'s Hamilton Standard Division, Windsor Locks, Conn.

**PAUL D. BLYSTONE** (General Motors Institute '53) is in GMC's Truck and Coach Division, Pontiac, Mich. Blystone is a senior detailer, engine design.

**FRANK J. HEYMANN** (Massachusetts Institute of Technology '53) is a research staff member in M.I.T.'s Division of Industrial Cooperation.

**H. MARVIN SMITH** (Purdue University '53) has become a research engineer for Ethyl Corp., Detroit.

**MARIO D'ONOFRIO** (College of the City of New York '53) is now with Sikorsky Aircraft, Division of United Aircraft Corp., Bridgeport, Conn. He is a weight control engineer.

**ROBERT C. OLHA** (Academy of Aeronautics '53) has joined Trans World Airlines, La Guardia Airport, New York, as an airplane and engine mechanic.

**THOMAS J. WALSH** (Chrysler Institute of Engineering '53) is in the development design department of Chrysler Corp. as a design engineer.

**GEORGE W. RICHARDSON** (University of Connecticut '53) is at the Savannah River Plant of E. I. du Pont de Nemours & Co., Aiken, S. C. He is a mechanical engineer.

**ANDREW J. BOZZELLI, JR.** (Johns Hopkins University '53) is now a research engineer in the automotive laboratory of Sun Oil Co., Marcus Hook, Pa.

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**HARRY J. MIKUS** (Carnegie Institute of Technology '53) is a junior engineer for the Worthington Corp., Harrison, N. J.

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**WILLIAM F. NUNNOLD** (Chrysler Institute '53) is a development engineer in Chrysler's Engineering Division, Highland Park, Mich.

**JAMES M. MICHAELS** (New York University '53) is a performance analysis engineer in development operations, General Electric Co., Evendale, Ohio.

**WILLIAM A. ELSTON** (Texas A & M '53) is in training in the Research Divison of GMC, Detroit.

**JOHN J. COOGAN, JR.** (Academy of Aeronautics '51) is an aircraft mechanic for Pan American World Airways, Miami International Airport, Fla.

# Color-Clean Oil No Clue to Lubrication

Based on paper by
H. M. GADEBUSCH
General Motors Corp.

AN entire generation of automotive men has grown up in the belief that clear oil color is a sign of interior engine cleanliness and trouble-free lubrication. This concept must be considered fallacious in the light of what we know today.

Combustion by-products account for by far the largest share of the solid contaminants in magnitude. Fuel soot is a predominant sludge ingredient of gasoline as well as diesel engines. Minute lampblack-like carbon particles together with the oil-soluble resinous oxidation products coagulate readily in the oil to sludge globules of larger size and have an exceptionally high discoloring effect on the lubricant.

With an engine operated on straight mineral oil and without an oil filter, the contamination curve first rises in direct proportion to the operating time, passes the "color-clean" mark and then begins to level out gradually, thus indicating that sludge deposition has taken place at some point in the engine interior. After each successive oil change a much higher percentage of contamination can be measured than accountable for by the small amount of dirty oil remaining in the engine after draining. The bulk of the deposits has obviously remained in the engine to contaminate the new oil change. Since the sludging point of the oil will thus be steadily advanced, frequent oil changes cannot insure absence of sludge deposits in an engine.

With an efficient by-pass filter coagulated carbon particles can be eliminated to maintain the oil in a "color-clean" range until a point is reached beyond which the reduced filter flow cannot keep up with the rate of contamination. From then on, the curve shows a gradual incline, passes the "clean" mark and resumes, finally, its initial slope as the oil filter flow ceases completely. Further operation without oil or filter changes will induce sludge deposition at the same contamination percentage as experienced without filtration.

Thus, absence of sludge in the crankcase may be achieved by keeping straight mineral oils in "color-clean" condition, but even the best filter cannot be expected to control accumulation in the oil of raw fuel, oxidized hydrocarbons, oxidation acids and water. These liquid contaminants are transparent and do not, as a rule, cause noticeable discoloration of the lubricant. Therefore, "color-clean" crankcase oil may be highly diluted, saturated with varnish-depositing oxidation products, and extremely dangerous with respect to bearing corrosion. Furthermore, as long as only by-pass filtration is used, speedy enough elimination of invisible wear-producing materials is not assured and "color-clean" oil may contain harmful quantities of abrasive contaminants.

Although combustion of more uniformly distributed and more easily vaporized fuel produces smaller amounts of soot, this advantage is more than offset by generation of considerable quantities of lead salts as a combustion by-product of the commonly added chemical octane number improvers.

Since most of the damage due to the solid contaminants will have been done before they can possibly be eliminated by an oil filter, the condition of pistons, piston rings and cylinder walls cannot be bettered noticeably by maintaining the crankcase lubricant in "color-clean" condition.

Heavy-duty lubricants, which are made from superior solvent-refined base stocks fortified with oxidation-

retarding chemicals, have a much greater heat resistance than the best straight mineral oils. The amount of varnish-forming oxidation products is greatly reduced and practically all danger of copper/lead bearing corrosion is eliminated. Liberal addition of "detergent" additives effectively counteracts coagulation of colloidal soot particles.

The immediate benefits obtained from heavy-duty lubricants were clean piston skirts and oil control rings as well as material reduction of deposit formation on compression rings. In the crankcase the contaminating materials became so intimately suspended in the oil that separation by gravity or centrifugal force is impossible. With these oils, sludge formation is effectively prevented as long as a balance exists between the amount of contaminant formed and the quantity of detergent available.

Dispersion of the carbon particles in their true submicronic size prohibits their retention by even the most efficient filter, therefore, with the use of heavy-duty lubricants the crankcase oil will rapidly blacken and retain the blackness for its entire life.

It must be remembered that the polarizing effect of detergent chemicals is definitely limited, therefore, the oil may become over-loaded with sludge-producing contaminants. Since sludge formation is an infallible indicator of detergency exhaustion, the following rule may be established for selection of the proper oil type:

If the oil filter elements are found coated with sludge at the time of a normal oil change, then either the oil change period must be reduced or lubricant of the next highest detergency should be used. (Paper "Clean Crankcase Color or Clean Engines?" was presented at SAE Northern California Section Regional Meeting, San Francisco, March 25, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

## Chain Saw Engines Suffer Lube Problems

Based on paper by

**F. DAVISON**
Industrial Engineering, Ltd.

LOAD characteristics are particularly hard on the small two-cycle engine of a power chain saw. Under normal cutting the speeds are fairly constant, varying from 500 to 600 rpm, and on occasion as much as 1500 rpm. When difficulties are encountered in operation, speeds may vary from 3000 up to 7000 rpm and back again.

The internal surface temperatures

which prevail render the lubrication problem severe, the only fortunate circumstance being the cooling effect of the fuel and oil mix on the running parts in the crankcase. Indications are that the mix on entering the crankcase stays for several cycles and a partial separation takes place. Thus, the engine is lubricated by splash with a heavily diluted oil, some of which is carried up to the combustion chamber via transfer ports while the remainder works up past the piston and rings.

A certain amount of oil is deposited at each cycle on the exhaust ports where it is subjected to the outgoing gases. The lower the viscosity of the oil and the less of it in the mix, the less the deposits, but about SAE 30 seems to be the minimum, presumably because of heavy dilution. Sixteen to one seems to be the lightest mixture practicable, while twelve to one is generally recommended.

Folklore regarding lubrication has it that straight mineral oil or no additives is the best for lubrication. This is refuted by tests which show the best oil to be mildly detergent and the worst to be straight distillate with no additives. It now appears reasonably certain that heavily compounded oils are not as satisfactory as slightly compounded ones.

Repeatability of oil tests was remarkably good and in most cases the oil was run with leaded and unleaded fuel to see if there could be any observable interlocking result. In no case did the oil alter the effects of the fuels. A good many oils showed up fairly satisfactorily, as they have in the field, and in all cases oils with good field reports were reasonably good under test. (Paper "Small Two-Cycle Combustion and Lubrication Problems" was presented at SAE International West Coast Meeting, Vancouver, B. C., Aug. 17, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

## Hydra-Matic Tested In Light Truck Service

Based on paper by

W. W. EDWARDS

General Motors Corp.
Truck & Coach Division

THE Hydra-Matic transmission has two principal advantages for truck installation. It eliminates the human element as much as is practical, and has less need for maintenance than a conventional unit. Every component is constantly flooded with oil, which means less wear and tear. Experience indicates no need for adjustments oftener than at 15,000 to 20,000 mile

intervals, assuming normal operating conditions.

One drawback is the impossibility of operating a power take-off directly off the transmission. Futhermore, although it is a four-speed transmission, the first speed does not have as low a ratio as a conventional four-speed syncro-mesh. It should not, therefore, be expected to serve for off-the-road work where the greater first gear reduction of the conventional transmission is indicated. At present, it is intended as a replacement for the conventional three-speed transmission alone. (Paper "Advantages and Disadvantages of Hydra-Matic Transmissions in Truck Operation" was presented at SAE Summer Meeting, Atlantic City, June 10, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

## Heavy-Duty Vehicles Cry for Better Brakes

Based on paper by

**J. DOUGLAS BENNETT**

Federal Fawick Corp.

THE trend of heavy-duty vehicles toward increased gross weight, higher speed, greater payload, and lower chassis weight, has a definite effect on brake design. Brakes must be more efficient and lighter, since the braking system represents a considerable part of total vehicle weight.

Recently, brake diameters have been reduced from 17½ to 16½ in. and there is a tendency to make still further reductions. To accomplish this, however, brakes must be made more efficient.

At the SAE 1952 Summer Meeting, G. A. Fazekas brought out that changes in shoe temperature and curvature tend to lag behind those of the drum as it heats. If the shoe has a perfect fit in the drum when cold it will not have the same fit when hot, therefore, from this imperfect mating there will be intense local heat concentrations resulting in only partial contact of friction material, brake grab and fluctuating torque. Such localized temperature, in turn, results in heat checking of drum and rapid deterioration and wear of brake lining. Thus, the industry is concentrating on design to maintain full contact of friction material with brake drum.

In brake drum flange design the fundamental object is great torsional rigidity and greater radial flexibility to avoid bell mouthing.

Many avenues are being followed, but for the most part brake drum design seeks more rapid and more uniform dissipation of heat through the use of fins and high thermal conductivity material. Rapid strides are being made in brake drum metallurgy,

while considerable research is being carried on with asbestos based materials and metallic compositions. In the last analysis, designing a more efficient brake is a three-fold problem involving correct application of pressure, coefficient of friction and heat dissipation. (Paper "Post World War II Development in Heavy Duty Vehicle Brakes" was presented at SAE International West Coast Meeting, Vancouver, B. C., August 18, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

## Good Brakes Always a Compromise

Based on paper by

**P. J. REESE**

Wagner Electric Corp.

A perfect braking system should vary the brake effort distribution in accordance with the transfer of weight from the rear to the front wheels during deceleration. However, this is not feasible since all wheels can develop their maximum friction only at one rate of deceleration. The solution to the problem of distributing brake effort to suit various body types and possible load distribution must be a compromise.

With commercial vehicles the wide variation in weight per wheel from empty to full and overload makes imperative designing with brake distribution between front and rear wheels so that fronts won't skid before the rears when loaded and on slippery roads, yet keep the rears from skidding too easily when empty. The final solution is a compromise based on road tests—empty and loaded, and past experience. (Paper "Automotive Brakes" was presented at SAE Kansas City Section, Kansas City, March 13, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

## Driver is One Key To Lower Truck Costs

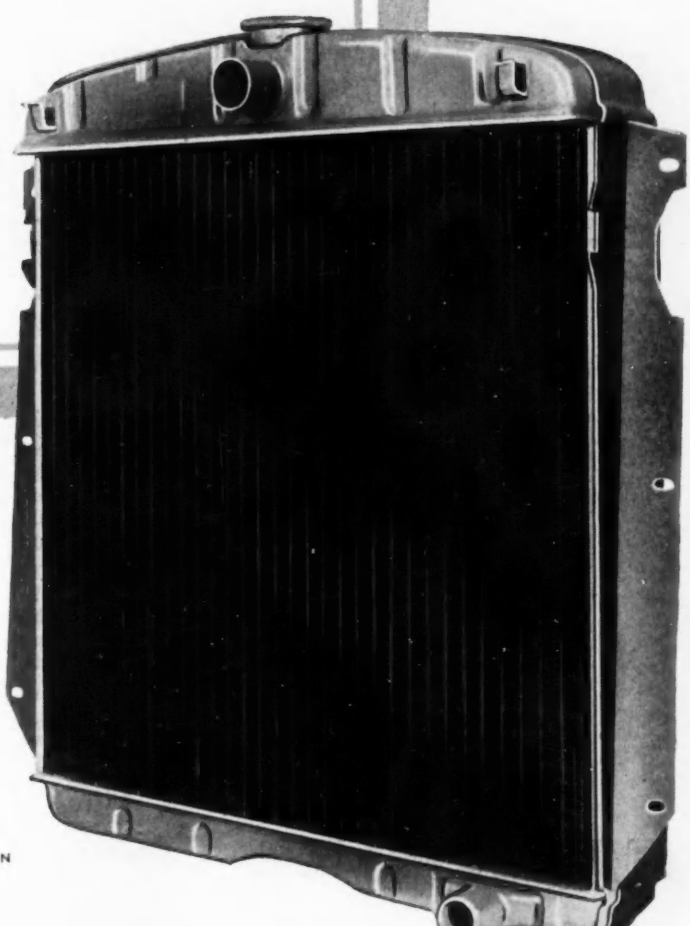
Based on paper by

**T. W. LAUER**

The White Motor Co.

EVERYONE has been conscious of the need for improving driver relationship and cooperation, but the opportunity for exploring and developing its

# An investment in good cooling



**HARRISON RADIATOR DIVISION**

GENERAL MOTORS CORPORATION
LOCKPORT, NEW YORK

**HARRISON**

possibilities has not been exercised in all cases. Driver responsibility has been recognized and understood for a long time, but certain intangible psychological factors have been treated lightly. Some of these are:

1. Encouragment of clean habits of person and within cab.
2. Providing suitable dress for uniformity throughout an operation.
3. Keeping drivers assigned to the one and the same vehicle.
4. Meeting drivers periodically to provide a two-way street for communication.
5. Minimizing down time by giving driver time to talk about his vehicle. Have a plan to use the driver's intimate knowledge about his equipment.

Driver selection should be used to create a fraternity—an esprit wherein drivers accept each other, not only for their individual skill, but with justified self-esteem and high morale. (Paper "Better Vehicle Maintenance at Less Cost" was presented at SAE Southern California Section, Los Angeles, Feb. 19, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

# Sports Car Has Its Place


Based on papers by

JAMES K. GAYLORD
Gaylord Products, Inc.

and

NORMAN E. CARLSON
Point Engineering Corp.


SPORTS car supsensions are often highly unorthodox, but some do resemble American passenger car practice. Among the unorthodox one may find the split axle method which forms an independent front suspension with single arms whose fulcrums are close to the middle—giving a roll center of almost hub level.

One of the most interesting is the trailing link or trailing arm type, which employs a member running almost longitudinally from the front cross member to the rear and which may in turn incorporate either a torsion bar or coil spring. This system boasts of a nil chamber variation in operation and allows the wheels to be dragged over the bumps instead of being pushed into them.

On the orthodox side there is the

double wishbone type, employing lower A frames, coil springs, and upper arms of equal or unequal length. These may utilize either coil springs or torsion bars, or perhaps leaf springs.

What the sports car buyers believes he finds in his purchase is, in general, the ability of the machine to do certain desired things in certain desired ways. He has the feeling of being part and parcel of the vehicle, of intimacy with the machine and its functioning, of close accurate control, of feeling the road—the engine; the feeling of being the master of a tight concise safe bundle. The usual isolation and insulation between driver and machine is missing.

Another satisfaction from sports car ownership can be traced to the acquisition of new skills and gratifications. Men who have scarcely ever lifted a hood of a standard automobile, will after acquiring a sports car, become Saturday and Sunday mechanics. (Paper "The Sports Car on the American Scene" was presented at SAE Detroit Section, Detroit, Feb. 16, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

## Engines Can Be Happy On Diet of Raw Fuels

Based on paper by

**W. G. NOSTRAND**

Winslow Engineering Co.

DECREASING availability of high grade fuels together with their increasing cost has forced operators, primarily in isolated locations, to turn to raw or residual fuels. In many instances this low grade "diet" has created internal ailments more costly to cure than the savings obtained through its use.

The major engine illness thus created is "acid indigestion", that is, undue and unnecessary wear due to the introduction of acid or corrosive products into the engine system. In practically all cases, engine trouble in conjunction with raw fuel use is met where the fuel is considered "sour". And "sour" is applied to crude oil, well head gas, or residual type fuels is generally meant to mean the presence of dissolved sulphur compounds which can be in the form of mercaptans, hydrogen sulfide and others.

Laboratory and field experience lead us to believe that the actual percent of sulphur compounds in the fuel is not as important as the condition of these compounds—they must be in a dissolved form in order to become

active or corrosive within an engine.

In addition to corrosive action, there is the problem of removing other contaminants. In crude oil, drilling mud, asphaltum, gum, acid and water are of the greatest concern. In the case of residual fuels the problem is large percentages of transportation dirt, asphaltum, carbon and very definitely water. With well head gases we are concerned with sand, petroleum, fluid and the trouble-maker, water.

In filtering and processing crude and residual oils, most of the moisture must be removed as well as the contaminants, thus, the dissolved sulphur compounds are eliminated or cut to such a low percentage that an acceptable increase in engine efficiency is the result. The actual percentage of sulphur present in the fuel before and after treatment is not the measure of the effect of sulphur on the engine. If we remove the water and along with it the dissolved sulphur compounds we have a fuel which gives satisfactory performance.

Although the process for handling gas differs from that of crude oil, the objective is much the same. All solid contaminants and all liquids are removed in order to eliminate abrasive action and harmful corrosive products. It is impossible to make any accurate correlation between sulphur grain content removed and improvement in engine operation and service. In many instances it has been determined with reasonable accuracy that the amount of sulphur removed was very small but engine performance improved tremendously.

Indicative of the improvement gained through this purifying process is the case of an engine on which spark plug and other service operations were required every 48 to 72 hrs before treatment, whereas after gas treatment spark plug changes were made every 500 hrs. In another instance a similar procedure resulted in major inspections being required every 14 months instead of major overhauls every 3 to 6 months, figuring 8 bearings and rings at 14 months. (Paper "Your Engine Can Be Cured of Acid Indigestion" was presented at SAE National West Coast Meeting, Vancouver, B. C., August 17, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

**Based on Discussion**

**L. T. Brinson,** Norberg Mfg. Co.

The problem of engine wear has not been resolved into an organized set of evaluated variables. We have been able generally to distinguish between good and bad influences, but the problem of evaluating the effect of various fuel contaminants has only been scratched. The complexity of the problem makes it mandatory for engine builder, petroleum industry and filter people to supplement each

other's efforts to make operating data meaningful.

**Questions and Answers**

**Q. P. L. Pinotti,** California Research Corp.

It was mentioned that sulphur type compounds show and aggravate wear while sweet fuels do not. Please elaborate.

**A. Author**

In gas engines using a dry fuel, or diesel engines using a so-called "wet" fuel, the moisture produced by combustion is always present to combine with sulphur to form wear aggravating compounds.

**Q. J. A. Edgar,** Shell Oil Co.

What are the filter material balances? Has a complete analysis of material held by filter been undertaken?

**A. Author**

No successful attempt to establish material balances has been made as yet. This would involve a complete chemical analysis of the materials.

**Q. I. E. Howard,** Clark Equipment Co.

Is there need for filtration or treatment of L.P.G. fuels?

**A. Author**

Occasionally highly contaminated batches of L.P.G. are encountered, but it is unusual. Some operators have a low pressure filtration system between the regulator and the carburetor which is successful in removing sulphur and petroleum tars which cannot be removed on the high pressure side. High pressure filtration units are used to remove rust, silica, etc.

## Traffic Problem Needs New Approach

Based on paper by

CARL G. SEASHORE

Carl G. Seashore Associates

CIVIC traffic accident prevention calls for a mobilization of all known preventive measures. It needs an All-American team of men each of whom is a specialist in one area of traffic safety, such as driver training, law enforcement, clinic for repeaters, and the like. Men of high caliber are available and could be brought together to work on the problem in one community. This would set a pattern which could be expanded on a national scale. (Paper "Preventioneering—A Business Approach to Traffic Safety" was presented at SAE Colorado Group, Denver, May 21, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

## New Members Qualified

These applicants qualified for admission to the Society between Aug. 10, 1953 and Sept. 10, 1953. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

**Atlanta Group**

Fred Carroll Runfola (M).

**Baltimore Section**

Harold Jennings Harvey (J), Nicholas V. Petrou (M), LeRoy T. Wallick (A).

**British Columbia Section**

Rodney Haslam Baird (A).

**Canadian Section**

John K. Abel (M), Maciej Achmatowicz (A), Wolfgang A. Kempff (M), D. Clifford King (M), James C. Macdonald (M), William Dominic McCullough (A), Thomas E. McLeod (A), John Greenwood Slaven (J), Charles Franklin Stevenson (M), Louis Tereschuk (M), Harry Wogden (M), Leslie Thomas Woodhouse (A).

**Central Illinois Section**

Robb P. Brem (J), Ralph J. Furstoss (M), Oscar M. Harding, Jr. (A), Paul A. Mitchell (J), Loren Derol Munro (J), W. P. Sebree (M), T. H. Spencer (M).

**Chicago Section**

William Strock Alexander (A), Robert William Bowers (J), John R. Branstrator (J), Robert Keith Brown (M), Harry J. Dagley (A), T. C. Delker (M), D. J. Gardner (J), Ray E. Kath (A), M. P. Kleinholz (M), Henry Knippenberg III (M), Steve F. Sipovic (M), Jack Pershing Stanton (M), Joseph G. Stieber (M), Arthur F. Szydlowski (J), Nils A. Thunstrom (M).

**Cincinnati Section**

Harry A. McFarland (M).

**Cleveland Section**

Geo. E. Armington (M), Carl Howard Bacon (M), L. J. Bechhold (A), John L. Bigelow (M), Robert L. Chris-

Continued on Page 115

## New Members Qualified

continued

tian (M), Frank J. Di Natale (A), Henry Friedrich (M), William J. Gardner (M), R. E. Lee (M), George P. Mathews (M), James W. McConaghy (M), Harlan C. Paige (M), Paul L. Reed (A), Lewis R. Schilling (M), Russell L. Smith (M), Harold R. Sobeck (M), Nelson G. Spoth (M), Dallas L. Sprinkle (M), Taylor Wyckoff (M).

**Dayton Section**

Al Erhart (M), Leon Hall Fish (A), S. H. Hanville, Jr. (M).

**Detroit Section**

Joseph John Adamo (J), Charles E. Barby (A), Fred D. Barton (A), Bruce G. Booth (A), E. D. Caldwell (A), John D. Caplan (J), Ray C. Conner (M), Girard N. Conti (J), Donald J. Curran (J), Edward D. Dall (A), Peter L. DeVries (J), Rodney C. Dickinson (M), George A. Dow (M), Arthur R. Dulzo (M), William Benjamin Edmiston (M), John J. FitzGerald, Jr. (J), Charles Vernon Frizzell (J), Elmer A. Herider (M), Joseph Kechis (A), William Martin Kelly (M), Max S. Koga (M), Floyd G. Lawrence (A), William A. Lerg (M), Daniel P. Mathews (M), Edward H. McArdle, Jr. (J), Wendell Lafayette Minor (J), Charles R. Mitchell (A), Ronald R. Moalli (J), John J. Murphy (A), Robert Charles Nelson (J), Joseph Parus (J), Paul S. Paulsen, Jr. (J), Albert A. Pruchno (J), Borje Rosaen (A), Edward Metcalf Sawusch (J), Robert F. Shepherd (M), J. M. Sturm (J), Howard Clayton Sullivan (A), Walter R. Swanson (M), George W. Tannahill (M), Samuel Taran, Jr. (M), A. Stanley Thompson (M), Patrick J. Valant (J), Russell W. Walstrom (J), Chester F. Wells (J).

**Hawaii Section**

Roy R. Goya (A), Sam Harris (M), Charles W. Hart (M), Charles W. Read (M).

**Indiana Section**

Robert P. Loveland (M).

**Kansas City Section**

Evan D. Bolin (A), John Brown (A), R. C. Hedglen (A).

**Metropolitan Section**

Dogan H. Arthur (J), J. E. Ashman (M), Paul A. Binda (M), Gregory Jamieson Comstock (M), Charles C. Cozzens (M), William De Mayo (M), J. Nelson Frey (A), Maxwell H. Giden (J), Charles F. Gotschalk, Jr. (J), Joseph T. Gushue (A), Charles J. Knight (M), Samuel Ray (A), Ladislaw Edward Trefny (M).

**Mid-Continent Section**

Joe P. Stagner (M).

**Mid-Michigan Section**

Henry Thomas Daunt (A), M. L. Gilbert (M), Gerald L. Hoddy (M), Carroll K. Lenning (M).

**Milwaukee Section**

Hugo F. Budzien (M), Robert W. Eck (J), John Fredrick Jorgensen (M), James H. Lahey (A), Lloyd W. Ream (M), Clyde B. Sword (J).

**Mohawk-Hudson Group**

William C. Kraft (M), Harry Rose (M).

**Montreal Section**

Frank H. Rousseau (M).

Continued on Page 116

## New Members Qualified

continued

**New England Section**

Robert M. Gill (A), Irving Kalikow (M), Albert S. Kelley, Jr. (A), Paul Polidoro (A), G. Eliot Saunders (A), John G. Sheehan (M).

**Northern California Section**

Morris E. Cain (M), Ray W. Daugherty (A), Elmer M. McLachlan (A), Joseph M. Noble (A), Jay C. Paterson (A), Arthur B. Penniman (J), Halbert R. Reed (A), Robert T. Vogel (M).

**Northwest Section**

M. Duane Smith (M).

**Oregon Section**

Harold G. Bogue (A).

**Philadelphia Section**

W. Herman Barcus (M), Lawrence I. Chasen (A), John E. Mitchell (M), Charles A. Moyer (A), Gilbert Carl Sitz (M).

**Pittsburgh Section**

Earl E. Bischof (J), Colin Irving Bradford (M), Walther L. Havekotte (M).

**San Diego Section**

Raymond W. Brick (A), Richard V. Davis (M), W. G. Hubbell (M), Richard Teller (J), Melvin L. Williams (M).

**Southern California Section**

E. Maurice Baruch (A), John Hawley Brooks (J), Lt. Robert A. Curtis, Jr. (M), Theodore Eversole (A), Robert M. Garrett (M), Philip E. Holzman (M), Nelson A. May (J), C. Robert Nattress (A), Donald G. Phillips (J), L. K. Rimer (M), Arthur K. Vierra (J), Frank L. Wingo (M).

**Southern New England Section**

John Chamberlain (M).

**Syracuse Section**

Blair McClenachan (A).

**Texas Section**

Robert F. Mountz (J), Leif A. Zars (A).

**Texas Gulf Coast Section**

B. E. Gray (A).

**Twin City Section**

Richard Louis Bumgardner (J), Robert C. Butler (M), R. O. M. Grutle (M).

**Washington Section**

N. Stanley Oates (A), Lt. Col. Julio Salvador (A).

Continued on Page 118

# STROMBERG

## CARBURETORS

*Judge*

## Carburetor Value as though you were Buying rather than Building the Car!

Put yourself in your customer's shoes. *Lasting performance* is vital to him—and it's certain to effect the selection of his *next* car. It is only logical then, to specify components that will insure that characteristic in the engines you build. In carburetors, Stromberg is unique in this respect, for it is a proven fact that Stromberg* Carburetors *last longer*. Take the *long-range* view of carburetor value and you will agree, it's good business to specify Stromberg Carburetors.

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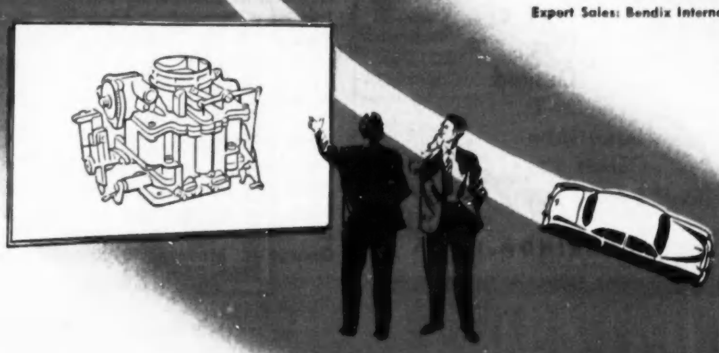
- Standard Equipment Sales: Elmira, N. Y.
- Service Sales: South Bend, Ind.

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.



## New Members Qualified

continued

**Western Michigan Section**

Joseph F. Keusch, Jr. (M).

**Williamsport Group**

Robert W. Edwards (M).

**Outside Section Territory**

Norman James Carlson (J), Percival Hagar Culverhouse (A), Major Grammer Grant Edwards (M), Robert W. Fernstrum (M), Parnell Haney (M), Thomas C. Kingsley (J), Henry J. Rasmussen (A), Paul T. Schultz (A), David Alison Shuler (A).

**Foreign**

William Charles Beer (M), So. Africa; K. W. Hermann Bertram (M), Germany; John Robert Langley (A), So. Africa; Dr. Hans List (M), Austria; Gordon F. May (M), England.

## Applications Received

The applications for membership received between Aug. 10, 1953 and Sept. 10, 1953 are listed below.

**Atlanta Group**

William Rawson Ramy, Sr.

**Baltimore Section**

Wayne H. Garrett, Jr., E. R. Gibbs.

**Buffalo Section**

Emil J. Vodonick, Car. O. Peterson.

**Canadian Section**

Thomas Bullough, Ellis Ezra Sion.

**Central Illinois Section**

Tom L. Burcham.

**Chicago Section**

David F. Allen, Jr., Joseph John Azzarello, Jr., James V. Cantolino, Robert L. Carlson, Laurel E. Carr, Harvey P. Ingelse, Bernard Johnson, James B. Kenny, Frank Ludicky, William E. Monroe, Kenneth G. Rice, William H. Thompson, Domenic P. Tortorici, Robert Lee Urban.

**Cleveland Section**

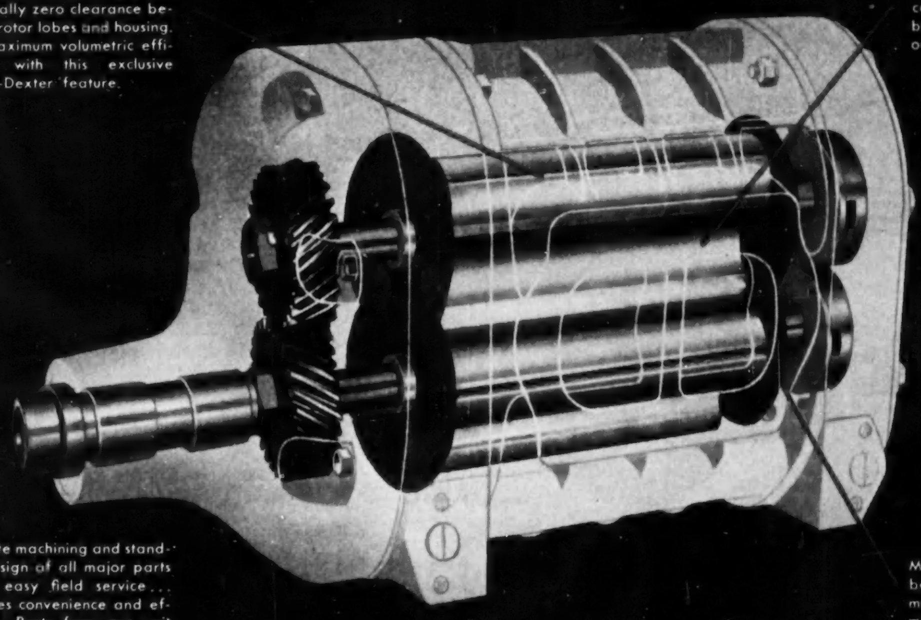
Sal Frank Artino, James M. Cherrie, Clifford C. Crabs, Leonard E. Foglesong, Earl Hobein, M. J. Hoke, Arthur R. Lamb, William Robert Meyer, George E. Mrdeza, Roland J. Petelka,

Continued on Page 120

# only MIEHLE-DEXTER superchargers give you these 4 big engineering advantages

Formica wear strips are locked into rotor lobes . . . provide practically zero clearance between rotor lobes and housing. Get maximum volumetric efficiency with this exclusive Miehle-Dexter feature.

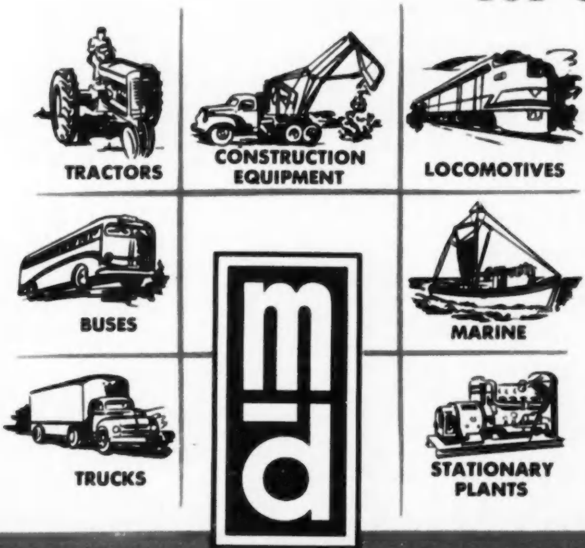
Here's a big plus . . . lightweight aluminum rotors and case. Little wonder up to 50% bonus power is available without penalty of added weight.



Accurate machining and standard design of all major parts allows easy field service . . . improves convenience and efficiency. Parts from one unit can be field installed in another of the same type.

Miehle-Dexter's patented rubber grid seal, vulcanized to metal end plates, eliminates metal-to-metal contact . . . assures long service life and achieves fuel savings.

## and add up to 50% more engine horsepower for all these applications too!




**The four exclusive features shown above are typical of the big difference between Miehle-Dexter superchargers and other units. Features like these pay off in *bonus power—up to 50% or more* when you put performance-proved Miehle-Dexter superchargers on Diesel or gasoline engines.**

**More, these features are the key to longer supercharger service life . . . efficient performance. There's a dividend in fuel economy, too.**

**Yes, if you want more usable horsepower without additional weight . . . without sacrificing valuable space, it's time to specify Miehle-Dexter superchargers. For more facts, call or write Miehle-Dexter.**

**MIEHLE-DEXTER SUPERCHARGER**

DIVISION OF THE DEXTER FOLDER COMPANY

100 Fourth Street • Racine, Wisconsin

## Applications Received

continued

Scott A. Rogers, Jr., Peter Van De Carr, Donald Wallace, Bertrand R. Warmeling, Warren J. Young.

**Colorado Group**

Ernest B. Wilson.

**Dayton Section**

Carl A. Anderson, Bail C. Peters.

**Detroit Section**

Ward James Atkinson, Robert Joseph Browne, Charles S. Chapman, Jr., Ellard Douglas Davison, Jr., Walter J. Hagen, C. L. Halpin, Walter Hintzen, Conrad J. Hohmann, Sidney D. Jeffe, Joseph P. Kreitmeyer, Arthur J. Larsen, Thomas A. Loewe, Edwin J. Marville, Jr., V. L. McEnally, Jr., Melvin Nadolny, Jerald Alvin Outland, Wesley R. Parker, Jack Pechenik, David Walter Peterson, Samuel S. Platner, Paul G. Racicot, Edward J. Rambie, George Romney, Ray Kenneth Schieb, Peter V. Schneider, Richard S. Seeley, Paul J. Smith, James Stewart, George E. Tozer, Edwin Rudolf Wanhala, Warren A. Van Wicklin, Jr., Harry T. Williams, Charles R. Wilson, George Wisniewski.

**Hawaii Section**

Nicholas Serra.

**Indiana Section**

L. L. Clark, Joseph J. Foyst, Edward Junior Hollman, John B. Mastin, Eugene Grant Matkins, Robert G. Walker, Richard E. Young, John S. Craig.

**Kansas City Section**

R. L. Davis, Robert Ellerman Langley, G. J. Shaw.

**Metropolitan Section**

Herbert S. Coleman, Theodore C. DuMond, Elpidio P. Duque, Henry B. Fernald, Jr., Frederick P. Clazier, Robert E. Helmus, Harry Judson Holcombe, James England Hulsizer, Don Riccardi, Harlan M. Smith, Henry J. Sossong, Stanley Roy Spector, George F. Weber, Harry D. Weller, Jr., George E. Wilson.

**Mid-Continent Section**

Leon M. Oswalt.

**Mid-Michigan Section**

Robert Carver, Thomas Pavlovich.

**Milwaukee Section**

Norman Robert O'Hara, Paul W. Wahler.

**Mohawk-Hudson Group**

Joseph J. Milich, Glenn Raymond

Continued on Page 122

## Applications Received

continued

Stevens, Jr., George E. Veen, Jr.

**Montreal Section**

Joseph M. Brian, John Frederick Frank, William Marshall Seath, John D. C. Waller, Murray E. Wight.

**New England Section**

Norman Henry Bell, Edward A. Downs, Clifton N. Lovenberg.

**Northern California Section**

Val Gates, Eugene Sidney Moulic, Jr., James M. Ray, Roy Alfred Renner, Richard C. Wilson.



**Northwest Section**

Darell A. Buell, Louis Glist.

**Philadelphia Section**

Capt. Wellington T. Hines, LeRoy F. Meredith, Jr., Harold N. Meyer, Robert D. Miller, Theodore W. Nelson.

**Pittsburgh Section**

William Rudolph Hellner, Howard B. Hile, Edward A. Jamison, Arthur Edward Mikoleit, Louis Eugene Pourron, Jr., Roderick S. Spindt, Frank J. Stodolsky.

**St. Louis Section**

Jefferson William Baker, Earl R. Lane, Fred T. Schick.

**Salt Lake Group**

Arlan E. Kelley.

**San Diego Section**

Wallie Paul Gray, Russell H. Thomas.

**Southern California Section**

Walter E. Barthel, George J. Chikar, Jr., Elmer D. King, V. H. Knowles, Robert A. Lohmann, Anthony William Magula, David Alexander Philipp, Charles R. Richards, Anthony Scotch, Otis A. Wright, Don A. Young.

**Southern New England Section**

Maurice Godet, Oscar A. Levi, Robert Louis McLeod, John W. Morse.

**Syracuse Section**

Walton Bertrand Baldwin.

**Texas Section**

Robert C. Breckur, Henry A. Clutz, William Raymond Cook, Ronald Eugene Freise, Joseph Henry Nadolski, James Edward Wier.

**Twin City Section**

Marvin A. Hendrickson, Robert L. McMillan, Charles H. Whitmore.

**Washington Section**

Conrad J. Bowman, John L. Lankford.

**Western Michigan Section**

Fred John Huston.

**Wichita Section**

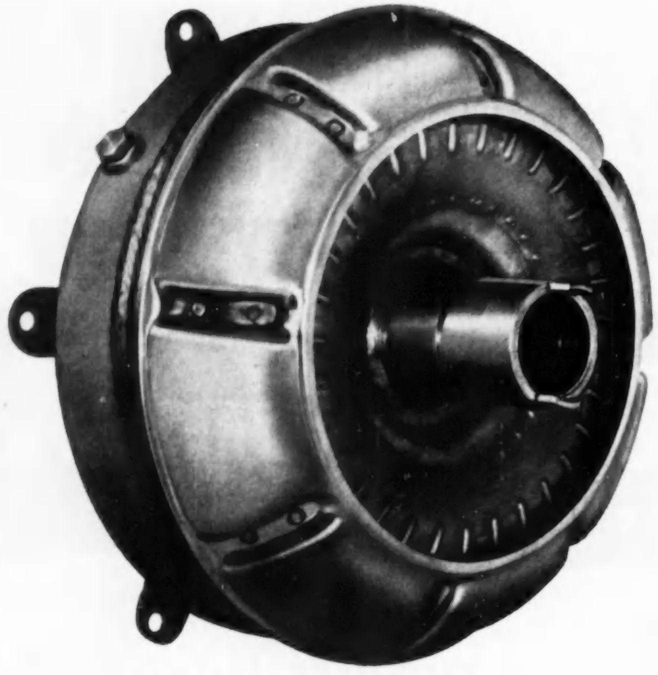
John H. Creighton, Howard Walter Hines, Donald L. Whitney.

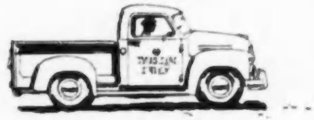
**Outside of Section Territory**

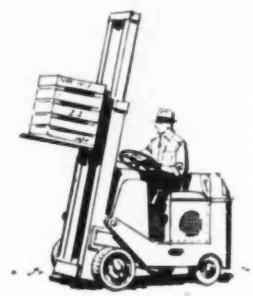
James A. Jones, W. Brooks Linthicum, Shih-Chien Kao.

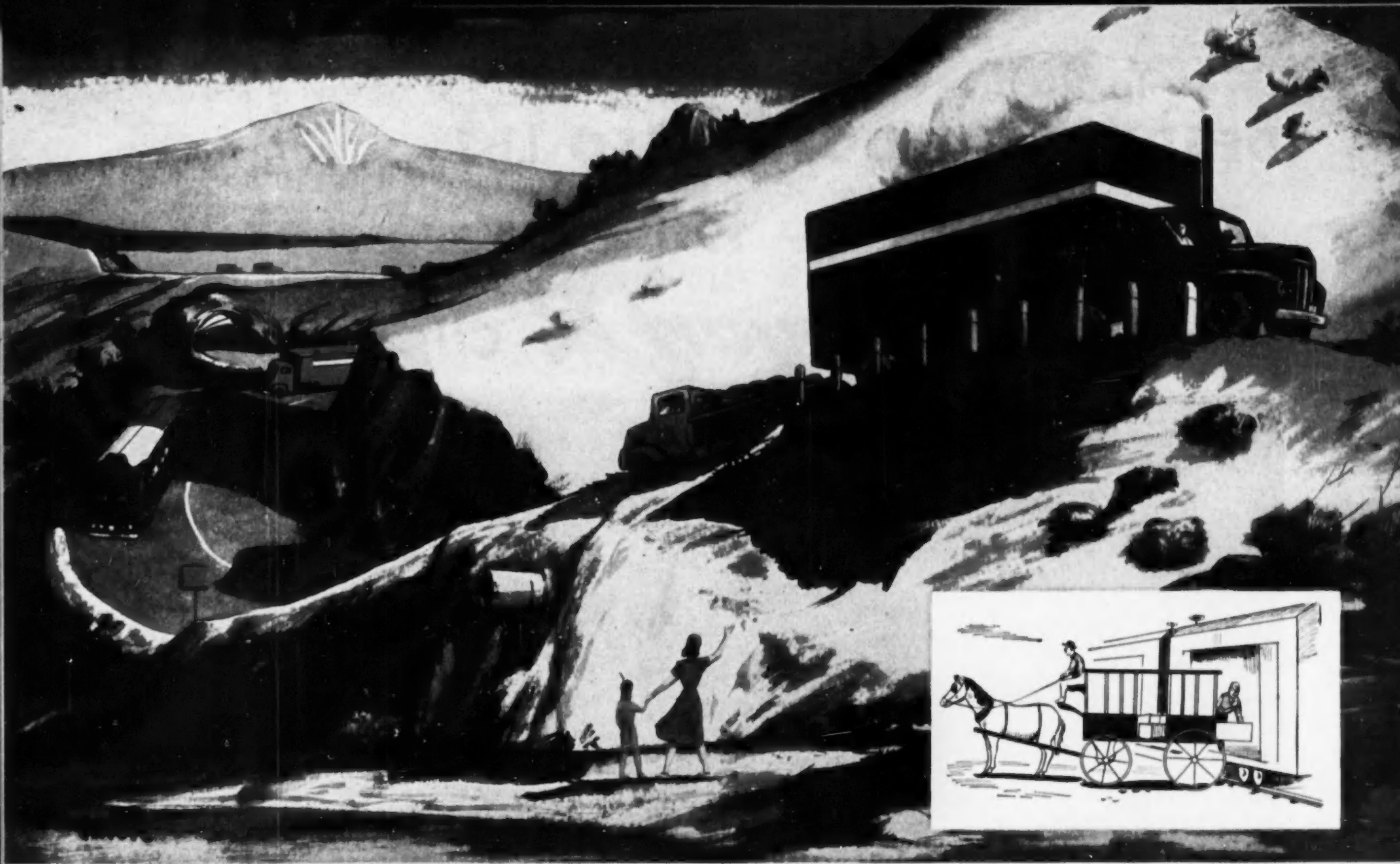
**Foreign**

Gopalkrishna Ganapathy Kudva, India; M. R. Lakshmi Narasimhan, India; Alejandro Senzacqua Perez, Chile; Jyotindra Manharlal Vakil, India.









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## On Our Golden Anniversary we salute the . . . . .

# *Truck and Bus Industry*

Over rolling hills of the East, through the broad, flat Midwest plains, past the mountains and desert areas of the West rolls a constant caravan of trucks and buses, economically carrying travelers and commercial goods to every part of the nation. No longer is the small town isolated, dependent on "one stop a day" transportation or shipping schedules, for the trucks and busses have knit all America into a single unit.

The early days of the industry were beset with mechanical delays and disappointments, but finer engineering, better production methods and precision-made parts make it possible to meet dependable time schedules day and night, in even the most rugged terrain and under the toughest weather conditions.

Burgess-Norton, manufacturing piston pins and other precision parts, is proud to have served this important industry through these years.

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CLARK
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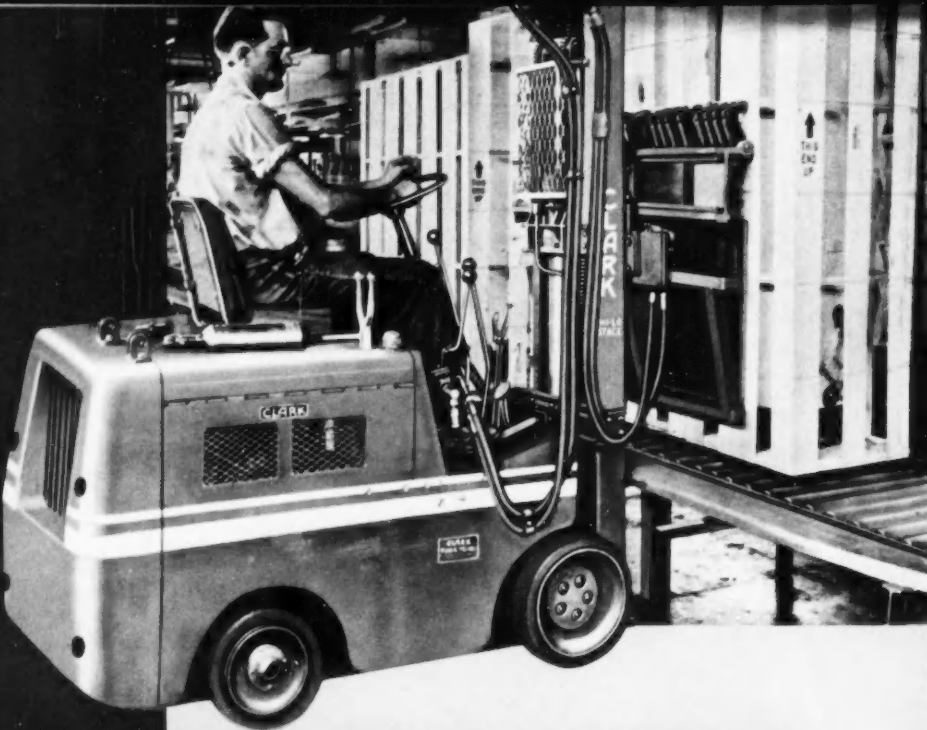
This unique housing—a one-piece, heat-treated forging—is the most widely used commercial axle housing. It is the result of seasoned, resourceful Clark engineering — which for you can mean substantial, product-improving benefits. It's good business to work with Clark.
Turn and see reverse side for more about CLARK products
CLARK EQUIPMENT COMPANY, Buchanan, Michigan
Other Plants: BATTLE CREEK AND JACKSON, MICHIGAN

# The A. O. Smith Corporation*




# SAVES $108,000 a YEAR

## in materials handling!

WITH A SPECIAL "FINGER LIFT" device for crate-handling combined with a side-shifting attachment for their fork trucks, the A. O. Smith Corporation not only reduced labor costs $108,000 a year, they also eliminated $16,000 worth of pallets plus "made available" [illegible] trucks for other work!

As usual, CLARK played a major role in this amazing savings achievement. Admittedly, not everyone can save $108,000 a year with modern handling equipment; but by the same token, you might save more, depending on the nature of your handling problem. Why not find out what's in it for you? Simply ask your CLARK Dealer to analyze your own particular handling activities. Don't pass up this opportunity for really big savings!

*[illegible]

**This is what the A. O. Smith Corporation accomplished:**

1. **Saved 43,300 man-hours or $78,000 a year in shipping and warehousing.**
2. **Minimized breakage and damage to crates, saved $30,240 a year on repair labor.**
3. **Eliminated 4000 double-faced pallets costing $16,000.**
4. **Accomplished a 30% reduction in required storage area—crates are exactly-positioned in neat rows, two, three and four high.**
5. **Cut boxcar loading time in half—one car is fully-loaded in one hour flat, by one man.**
6. **Eliminated hazardous difficult labor—all lifting is done mechanically.**

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*Products*—TRANSMISSIONS • AXLE HOUSINGS • TRACTOR UNITS • FORK TRUCKS and TOWING TRACTORS • ROSS CARRIERS POWRWORKER HAND TRUCKS • POWER SHOVELS • ELECTRIC STEEL CASTINGS GEARS and FORGINGS • FRONT and REAR AXLES for TRUCKS and BUSES

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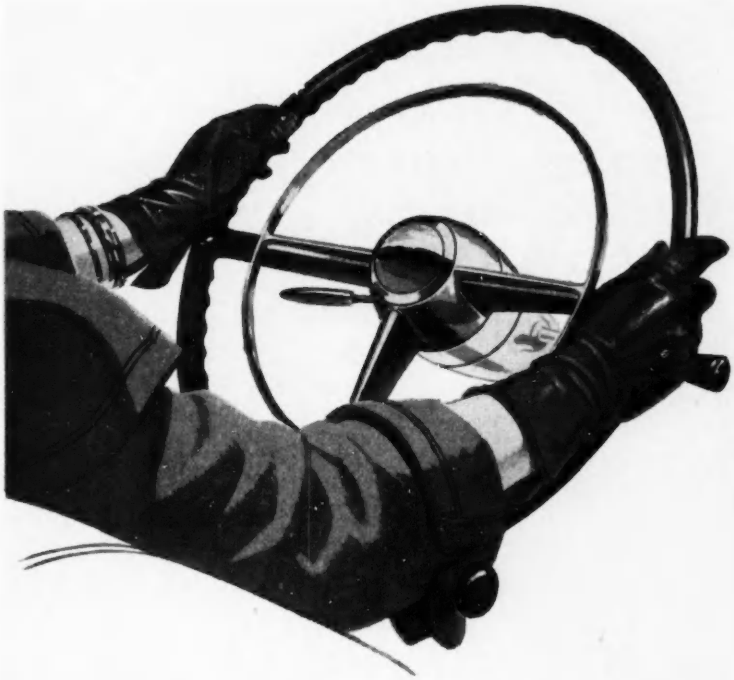
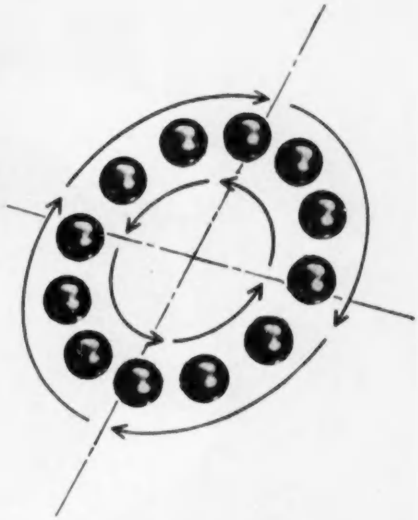
* DALLAS—3407 Main Street, Dallas 1, Texas
** DETROIT—18822 James Couzens Highway, Detroit 21, Mich.
* LOS ANGELES—1110 South Hope St., Los Angeles 15, Cal.
* PHILADELPHIA—1545 West Belfield Ave., Philadelphia 41, Pa.
* PORTLAND—636 N. W. 16th Ave., Portland 9, Oregon
* SAN FRANCISCO—424 Bryant Street, San Francisco 7, Calif.
* TORONTO, ONTARIO—The S. K. Wellman Co. of Canada, Ltd., 2839 Dufferin St.
** WASHINGTON—1101 Vermont Ave., N. W., Washington 5, D. C.

** EXPORT DEPARTMENT—8 South Michigan Ave., Chicago 3, Illinois

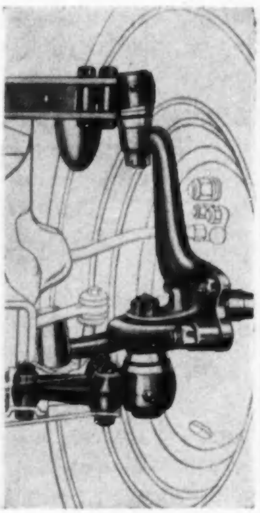
* SALES OFFICE AND WAREHOUSE ** SALES OFFICE



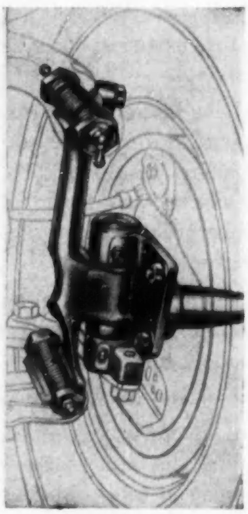


# Thompson Front Suspension Ball Joints

## *.....mean ball-bearing Steering Ease*



*Thompson Front Suspension Ball Joint*



*Standard King Pin Type Suspension*

*This Thompson "Engineered Steering" development is a good example of Thompson cooperation with the automotive industry. We are at your service too. Write, phone or wire Thompson Products, Inc., Detroit Division, 7881 Conant Ave., Detroit 11, Michigan.*

**PLUS** clear-cut solutions to *Six Other Major Problems* in manufacture and service.

- Creating new space for wider modern engine design
- Cutting the manufacturer's assemble-line cost
- Eliminating front suspension and steering bind
- Cutting front end overhaul time by *hours*
- Reducing lubrication points from 12 to 4
- Increasing service life *many times over*

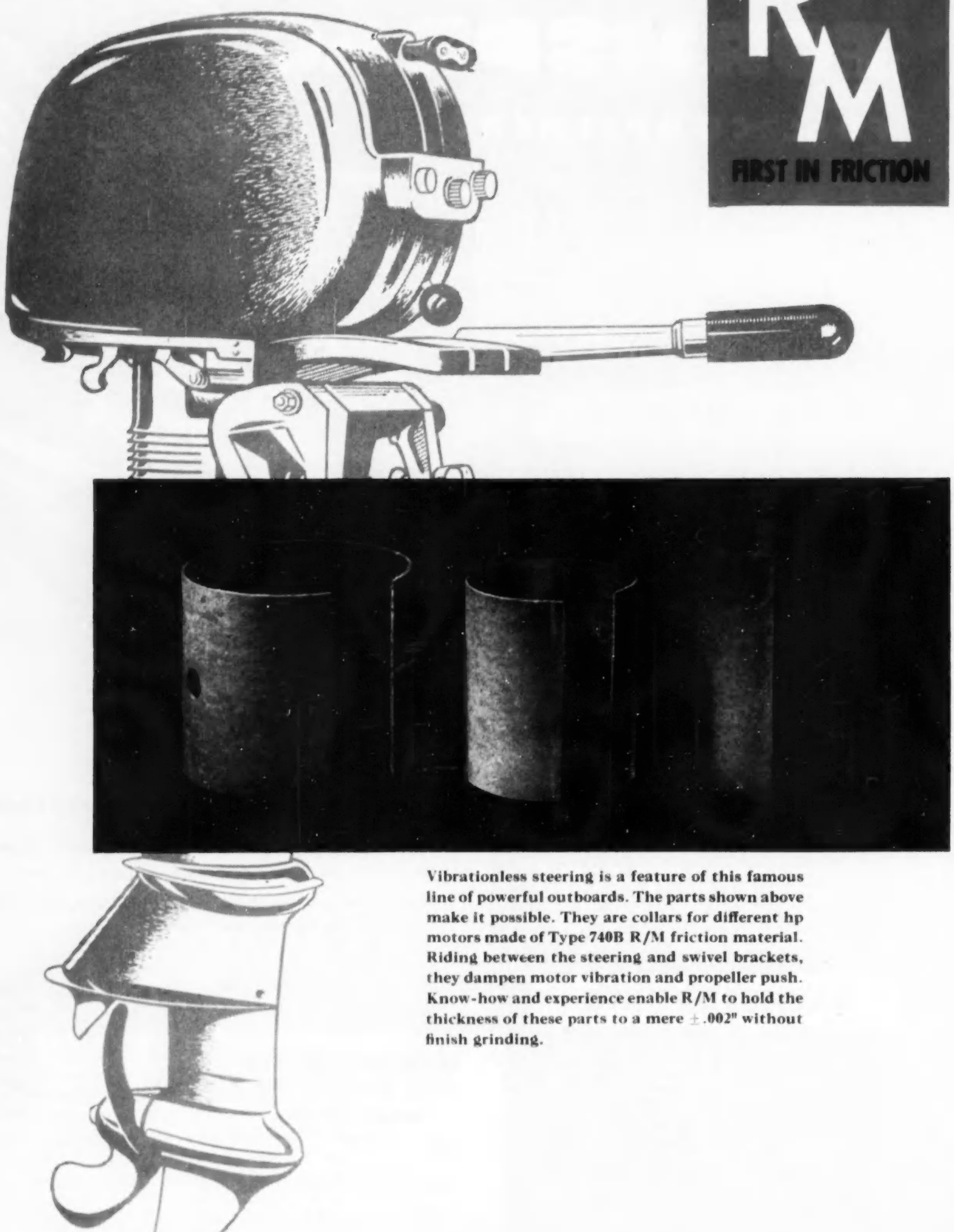
**You can count on**

**Thompson Products**

MICHIGAN PLANT

DETROIT • FRUITPORT • PORTLAND

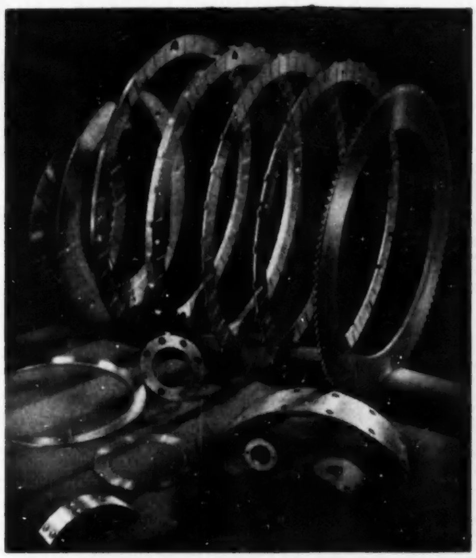

YOU'LL NEVER SEE
a near-sighted eagle
*High, high above . . . in the rarefied reaches of some rocky crag, roosts our patrician sky-pilot. Perched and pondering . . . his sharp piercing gaze images some far-off prey. Then . . . move in mind, he rides the wind – wide wings stretched in parabolic flight.*
When you're up in the clouds over new product development, take time to get the long view on the latest in methods and materials. Make sure you're aware of all that castings have to offer. And to get a real insight into what castings can do . . . there's none better to show the way than Campbell, Wyant and Cannon. A recognized leader in metallurgical engineering, precision control and mechanized production . . . CWC produces castings well known for their *longer* wearability, their *ease* of machining and their low cost. Of course, castings by Campbell, Wyant and Cannon also let you design with greater freedom . . . greater flexibility.
Let CWC help *your* product reach new heights. That way . . . maybe you'll have time to tour the flatlands of your favorite golf course.
CAMPBELL, WYANT AND CANNON
FOUNDRY COMPANY, Muskegon, Michigan
Manufacturers of Gray Iron, Alloy Iron, and Steel Castings
CWC
Since 1908



# THE TRADE-MARK THAT SPELLS PROGRESS IN FRICTION MATERIAL DEVELOPMENT!

For every obvious use to which R/M friction materials are put—brake linings, for example—there are hundreds of other important but "not-so-evident" applications. The story at the left tells about one of these.

Many manufacturers in many different industries collaborate with Raybestos-Manhattan, for R/M has a way of anticipating engineering needs and being ready to meet new requirements with advanced-design materials. R/M achieves its outstanding results by working with countless combinations of different types of friction materials . . . including woven and molded asbestos, semi-metallic materials, and sintered metal parts. If you have a friction material problem, call in your R/M representative. Behind him stand all the facilities of the world's largest maker of friction materials—seven great plants, their research departments and their testing laboratories.



*Sintered metal parts* are solving many problems in industry today. They're exceptionally useful where tolerances are close or operating conditions require immersion in oil. R/M's production capacity for these parts is keeping pace with demand.

*Write for your copy of the R/M Engineering Bulletin. It describes and illustrates many R/M friction materials for aviation, agriculture, the automotive industry and others.*

## RAYBESTOS-MANHATTAN, INC.

**EQUIPMENT SALES DIVISION 6010 Northwest Highway, Chicago 31, Ill.**
**Detroit 2 Cleveland 14 Los Angeles 11**

*Factories:* Bridgeport, Conn. Manheim, Pa. Passaic, N.J. No. Charleston, S.C. Crawfordsville, Ind. Neenah, Wis. Canadian Raybestos Co. Ltd., Peterborough, Ont.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Brake Linings • Brake Blocks • Clutch Facings Fan Belts • Radiator Hose • Industrial Rubber Products • Rubber Covered Equipment • Packings • Teflon Products • Asbestos Textiles • Sintered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

R/M FIRST IN FRICTION


# Turquoise transfers plans to paper more quickly, clearly, accurately ... thanks to 100% *"ELECTRONIC" GRAPHITE

**"Electronic"** is Eagle's trade name for a blend of crystalline graphites of highest purity, reduced to particles of micronic fineness in our patented Attrition Mill. 100% "Electronic" graphite in every Turquoise lead gives you super-service in four important ways:

**Super-Smoothness!** Turquoise leads are smoother, faster. No harsh impurities slow your line or scratch the paper.

**Super-Strength!** Turquoise points don't crumble. The microscopic graphite particles combine with the clay binder to form the strongest, longest-wearing lead structure ever made.

**Super-Blackness!** Because millions more of super-fine graphite particles are compacted in every inch of its lead, Turquoise deposits denser, blacker, more even lines that reproduce to perfection.

**Super-Grading!** 17 individual, exactly controlled formulas of "Electronic" graphite and clay make 17 evenly spaced degrees that are uniform from end to end, from lead to lead, from year to year.

**SEND FOR FREE SAMPLES**
Just drop us a note, naming the degrees you desire and the dealer who supplies you.

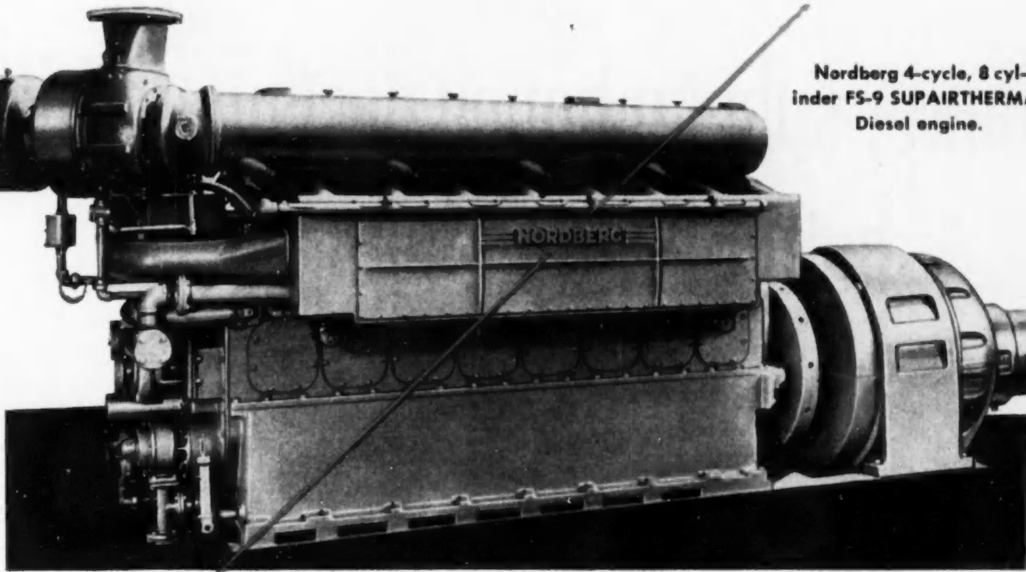
**EAGLE PENCIL CO.**
**New York • London Toronto**

*"CHEMI-SEALED" (Super-Bonded)

*EAGLE *TURQUOISE with 100% *"Electronic" Graphite

DRAWING PENCILS AND LEADS

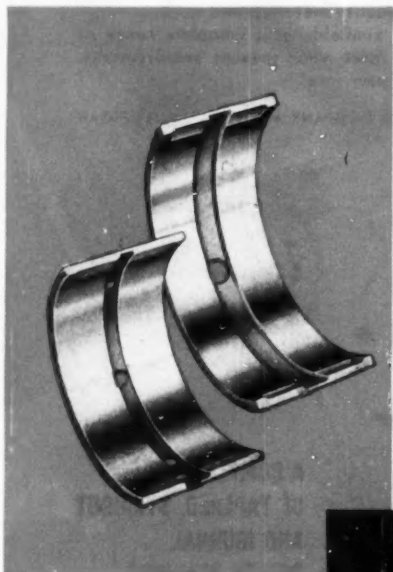
*®




Nordberg 4-cycle, 8 cylinder FS-9 SUPAIRTHERMAL Diesel engine.

## *a world-wide reputation for Dependable Service and Nordberg uses Dependable*

## FEDERAL-MOGUL BEARINGS



Producers of America's largest diesels, Nordberg builds with skill and experience. Big, powerful, dependable in service, Nordberg engines are famed from Milwaukee to Madagascar, from St. Louis to Singapore.

Federal-Mogul crankshaft and connecting rod bearings equip Nordberg's 9-, 13- and 16-inch bore engines. Helping put power to work *smoothly,* through silent sleeve bearings, has been a Federal-Mogul specialty since 1899.

FEDERAL Mogul

**FEDERAL-MOGUL CORPORATION • 11035 SHOEMAKER AVENUE**
**DETROIT 13, MICHIGAN**

Sleeve bearings in a wide range of designs and sizes; cast bronze bushings; rolled split-type bushings; bimetal rolled bushings; washers; spacer tubes; precision bronze parts and bronze bars.

# FEDERAL-MOGUL


bright
strong
easy to
form
for everything
AND the kitchen
sink
SINK RIMS are an excellent example of Superior Stainless in service—all the way from initial ease of fabrication, through simplicity of installation, to life-long durability on the job. Rims of Superior Stainless stay bright with a wipe—can't rust, peel or chip—add value to the entire kitchen unit! • Let's help you find your profit-application for Superior Stainless Strip Steel. Write us about your product, today.
Superior Type 430
Stainless STRIP STEEL
Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA


THE MOST Trouble-free
IGNITION CONDENSER
EVER DESIGNED . . .
At low Cost too!
Let us design the condenser for your product or, we will make it to your specifications —
ECHLIN
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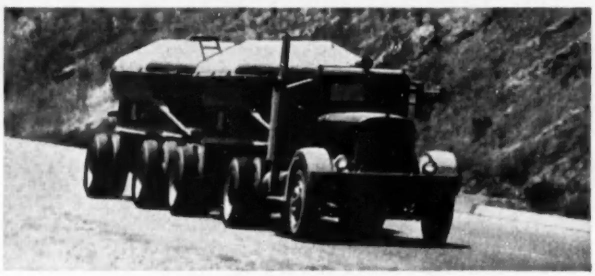
& OTHER AUTOMOTIVE
ELECTRICAL PARTS
A PRODUCT OF
ECHLIN
ECHLIN MANUFACTURING COMPANY · DEPT. SAJ, 200 EAST STREET, NEW HAVEN 5, CONN.

...the EXTRA BRAKING PERFORMANCE proven here...



...means SAFER, SURER STOPS on any hauling job!

*Smooth, Sure-Acting Bendix-Westinghouse Air Brakes Step-up Schedules, Safety and Profits on Rugged Runs!*

How would you like to help your truck customers shorten trip schedule time? Step up driver efficiency? Increase their margin of profits? Obviously, you would . . . *and you can* by simply taking a tip from the men who operate the big rigs over the rugged Rocky Mountains. Here, **under the toughest, most demanding conditions, fleet records show Bendix-Westinghouse Air Brakes help answer** all three questions. That's because these mighty brakes deliver the extra stopping power and performance that assure maximum control—anywhere, any time. As a result, **unnecessary slowdowns are eliminated because drivers know they can stop.** Thus, trip speeds can be increased, heavier payloads carried safely. In addition, Bendix-Westinghouse Air Brakes require less maintenance—overhead comes down because **trucks stay on the job instead of piling up expense in the shop.** So just add up all the advantages. No matter what type trucks you manufacture, give your customers the benefits of added performance and profits by specifying Bendix-Westinghouse, the world's most tried and trusted air brakes!

**Bendix-Westinghouse**

THE WORLD'S MOST TRIED AND TRUSTED

**AIR BRAKES**

BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY • ELYRIA, OHIO • BERKELEY, CALIF.

*Our Engine Bearings are specified as original equipment by the leading names in motordom because they have consistently contributed to better performance for more than a quarter century.*

MERCURY

Ford

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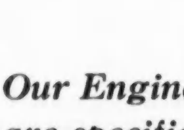
CASE

HERCULES



**DETROIT ALUMINUM & BRASS CORPORATION**

DETROIT 11, MICHIGAN


FS-747-A
USAF
"Dialed Flight"
for the REPUBLIC THUNDERJET
Flying at near sonic speed on a long-range ground support or bombing mission, the F-84 Thunderjet pilot needs a break, and gets it—welcome relief provided by his Lear Autopilot.
On the straight-away flight he can sit relaxed, conserving his energies for procedures requiring human decision. He changes course simply by "dialing" the kind and degree of change required on one of three knobs on his autopilot controller, or permits his Lear Autopilot to take over completely on the straight and level course. To a Lear Servo Unit, his Lear Autopilot transmits a signal—and smoothly, automatically, his craft takes on the desired attitude of flight.
Lear precision-engineered Control and Actuating systems and components, used extensively in military aircraft of all types, and in aircraft operated by major airlines, are aiding in the development of smoother, more economical and safer flight.
TURN
OFF
ON
UP
ROLL TRIM
LEAR AUTOPILOT SYSTEMS—
compact, light weight, automatically perform any normal flight maneuver. Used in commercial and military single, multiple-engine and jet aircraft.
DAMPING CONTROLS
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Lear®
Advancing the Frontiers of Flight
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OTHER INSTRUMENT PRODUCTS:
Automatic Approach Couplers and Flight Controls.
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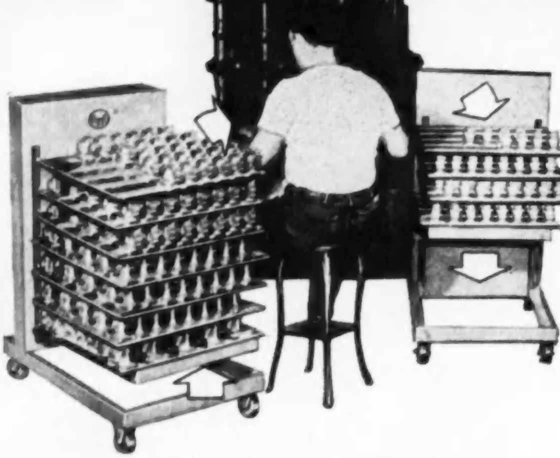
Missile Flight Controls • Rate Gyros.



# NOW...no stooping...bending...lifting with AMF Industrial Lowerator Dispensers!

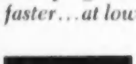
*Materials are automatically positioned at a convenient working level!*

The trouble-free calibrated spring action of AMF Industrial Lowerator* Dispensers *automatically* raises platform as material is removed...or lowers platform as material is placed on it.

But what is most important—whether the unit is full, half-full or nearly empty, the top layer of material is *always* automatically at a convenient working level!

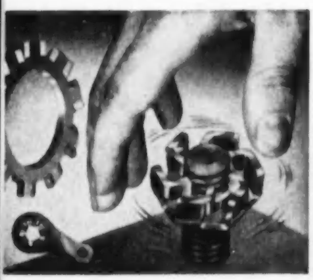
They are built to your exact dimension and load demands to meet your specific requirements. AMF Industrial Lowerator Dispensers make work easier for thousands of workers in many industries. The Automotive Industry was among the first to utilize their all-around advantages—planned quantities of materials, improved plant housekeeping, saved valuable floor space. These make for increased efficiency, reduced employee fatigue, better working conditions, and lower employee turnover.

This is another example of how AMF engineering ingenuity is helping the Automotive Industry to turn out *better products... faster...at lower cost!* Others are illustrated below.

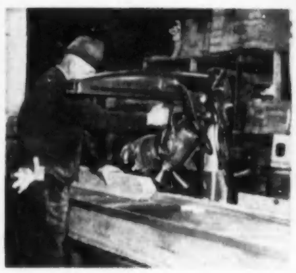


Send for free booklet, *"The Inside Story of AMF Lowerator Dispenser's Success in American Industry."* Address: American Machine & Foundry Company, General Products Group, 511 Fifth Avenue, New York 17, N. Y.

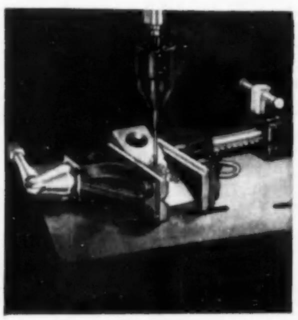
*Registered Trademark



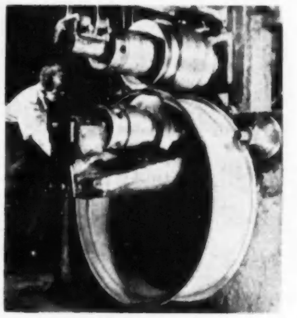
**ASSEMBLY IS SPEEDED** by AMF's Thompson-Bremer *Ever-lock** self-locking nuts, tooth-type lock washers and SEMS.



**SHIPPING AND MAINTENANCE** departments find AMF De Walt* Power Saws save time in all wood-cutting operations.



**AMF WAHLSTROM*** Fully-Automatic Chucks and AMF FLOAT-LOCK Instant-Change Safety Vises speed tool set-up changes.



**MAJOR SUPPLIER** of rims and circular weldments for the Automotive Industry is AMF'S Cleveland Welding Company.

*Tune in* **OMNIBUS** *Sunday afternoons for America's most unusual TV entertainment. See local paper for time and channel.*

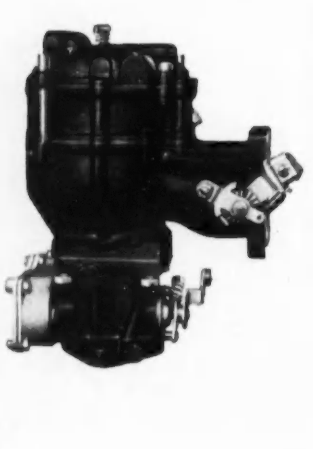
AMF products ARE BETTER...*by design*

AMERICAN MACHINE & FOUNDRY COMPANY


BOEING'S B-52
Heavyweight Champ
OF JETS
has CHIKSAN
Aero-Hydraulic Swivel Joints
Boeing's complete confidence in CHIKSAN Aero-Hydraulic Swivel Joints and Assemblies has been previously demonstrated by their selection, in the past, for the B-47 and B-50.
This confidence is further confirmed by Boeing's inclusion of CHIKSAN Swivel Joints and Assemblies in the new B-52 Stratofortress—an eight-jet heavyweight in the heavy bomber division.
Each airframe manufacturer's requirements become the subject of specialized study by CHIKSAN'S Engineering, Research and Development Division. Hydraulic Joints and Assemblies are designed to meet your individual requirements. Designs for all types of aircraft applications are available for handling hydraulics, fuels, oils, water, air, oxygen and other fluids.
CHIKSAN Hydraulic Aircraft Swivel Joints will handle pressures ranging from 1000 psi to 3000 psi.
CHIKSAN Aero-Hydraulic Swivel Joints and Assembly used on the Boeing B-50 braking system.
CHIKSAN Aero-Hydraulic Swivel Joints and Assemblies for 1000 to 3000 psi systems surpass all standards set down for both civilian and military use.
CHIKSAN low torque joints are also used in conjunction with rubber hose. This combination, utilizing the CHIKSAN swivel action at end of hose, provides flexibility and reduces kinking, twisting, and tearing of the hose.
The Flow of Enterprise Relies on
CHIKSAN
Ball-Bearing Swivel Joints
CHIKSAN
TRADE MARK REG.
Write CHIKSAN today for Catalog 2A "Aircraft Swivel Joints" — Dept. SJ-10
Representatives in Principal Cities
CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 28, Illinois • Newark 2, New Jersey
Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J.

# Will he Buy Your Truck Next Time?


# Zenith
## CARBURETORS



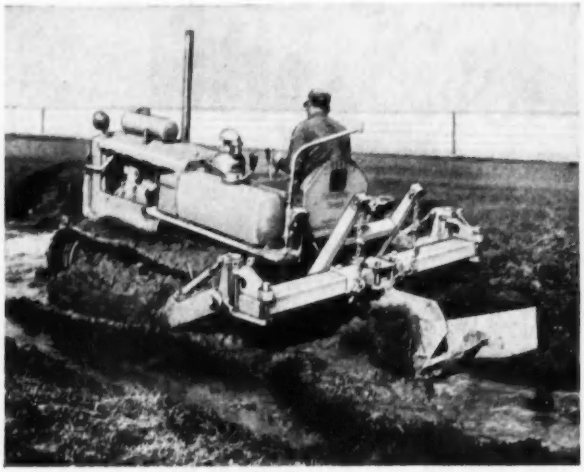
No manufacturer could long exist in the competitive commercial vehicle field without drawing heavily on previous owners for new vehicle sales. It is perfectly obvious, no owner would buy the same make vehicle again and again unless it has delivered satisfactory performance. Therefore, it is just good business to see that every component contributes its share toward building owner loyalty. That's why manufacturers whose vehicles are Zenith* equipped measure carburetion costs in lasting terms rather than initial expense. In the field of heavy-duty carburetion, one name, Zenith, has stood for lasting satisfactory performance for over a quarter of a century. Zenith's rugged construction, strong idling, freedom from stalling and response to every demand make it the engineers' choice. For good will, it's good business to specify the best—Zenith for lasting performance.

*REG. U.S. PAT. OFF.

**ZENITH CARBURETOR DIVISION OF Bendix AVIATION CORPORATION**

696 Hart Avenue • Detroit 14, Michigan

Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N.Y.



D4 Tractor, with ditcher attachment, dredges slough to drain into ditch beside road in Saskatchewan, Canada.

D2 Tractor, with Killefer chisel, renovates Bermuda grass in Arizona orange grove.

# Caterpillar's big yellow machines spotlight Bundyweld wearability

When fire runs through the forest . . . when the river rolls over the levee . . . in thousands of other less dramatic but equally vital situations . . . the big yellow machines from Caterpillar Tractor Co., are on the job. They're dependable. They *do* the job.

The durable Caterpillar Diesel Tractors, particularly, call for many different tubing applications: hydraulic transfer lines, fuel systems, fuel-tank-to-engine lines. Let's look closely at just one of these applications—the long line running from tank to engine, in models like the D2 and D4.

This important connection, main artery of the fueling system, must be absolutely leakproof. It must stand up under vibration, have high tensile strength, high fatigue limit. It must meet all the standards *uniquely* met by Bundyweld Tubing—so, of course, Caterpillar *uses* Bundyweld.

In trying to reduce the choice of Bundyweld to just one factor, Caterpillar engineers say, "wearability." Better than any other tubing, Bundyweld takes punishment day after day . . . year after year.

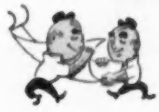
And Caterpillar engineers and production people like Bundy's fabrication ingenuity. This particular fuel line reaches Caterpillar exactly shaped, for quick, trouble-free installation.

Whether you need fabricated parts or straight lengths of Bundyweld (the *only* tubing double-walled from a single strip and copper-bonded throughout 360° of wall contact), it will pay you to talk over your application with a Bundy Tubing specialist. Call, write, or wire Bundy Tubing Company, the world's largest producer of small-diameter tubing.

**Drop in to see us at our exhibit in the National Metal Exposition, in Cleveland, October 19-23.**

**BUNDY TUBING COMPANY, DETROIT 14, MICHIGAN**

**WHY BUNDYWELD IS BETTER TUBING**



Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

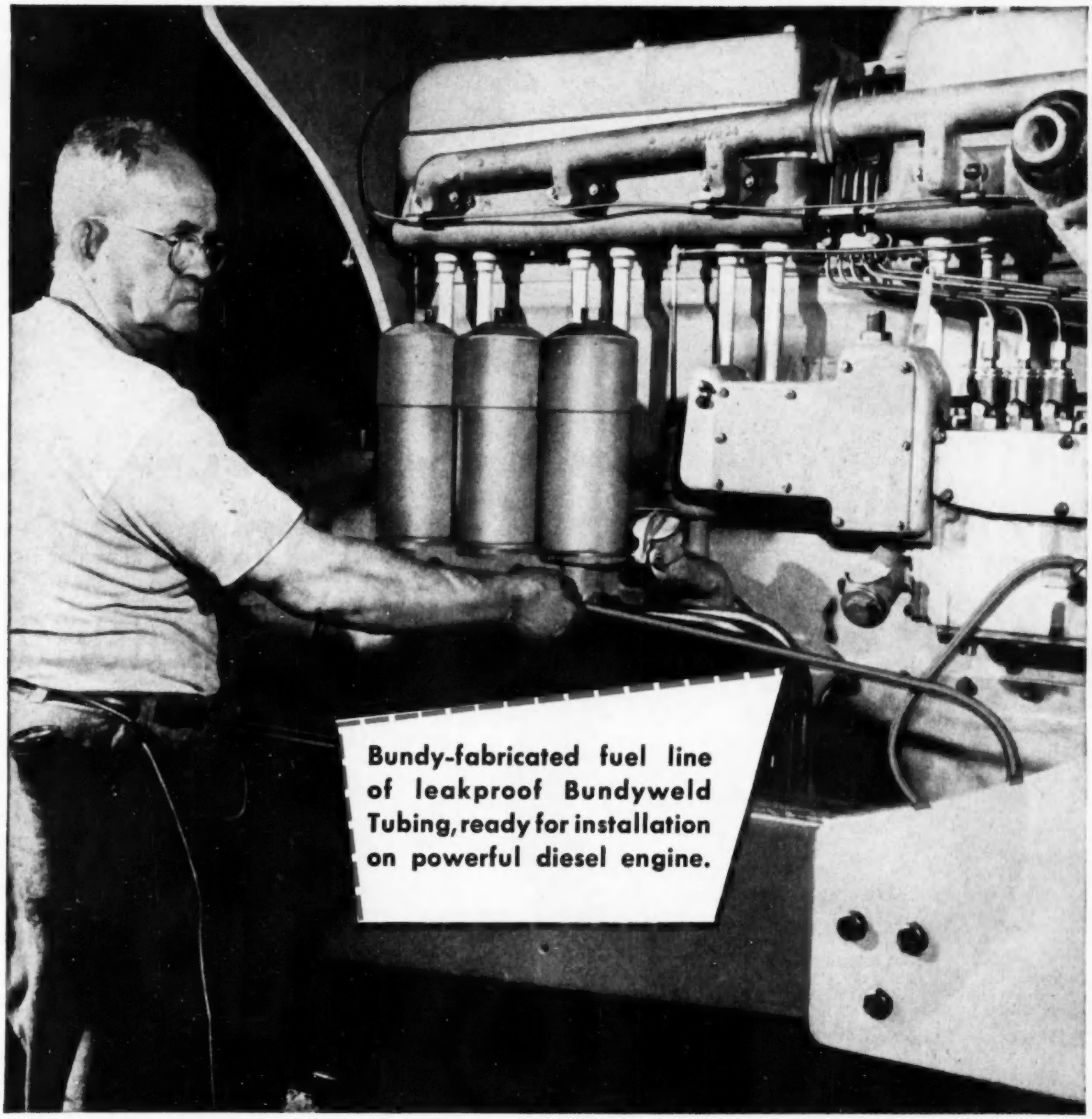

Bundyweld, double-walled and brazed through 360° of wall contact.

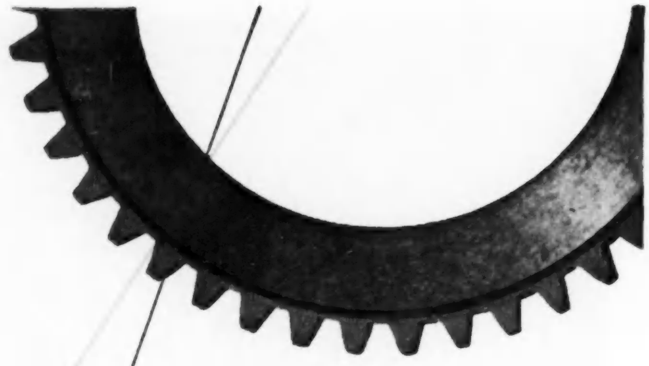

←

**NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

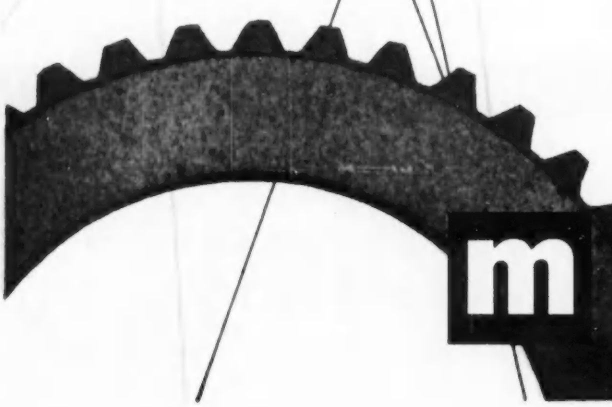
**Bundy Tubing Distributors and Representatives:** ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., East. • ***Bridgeport, Conn.:*** Korhumel Steel & Aluminum Co., 117 E. Washington St. • ***Los Angeles 58, Calif.,*** Tubesales, 5400 Alcoa Ave.

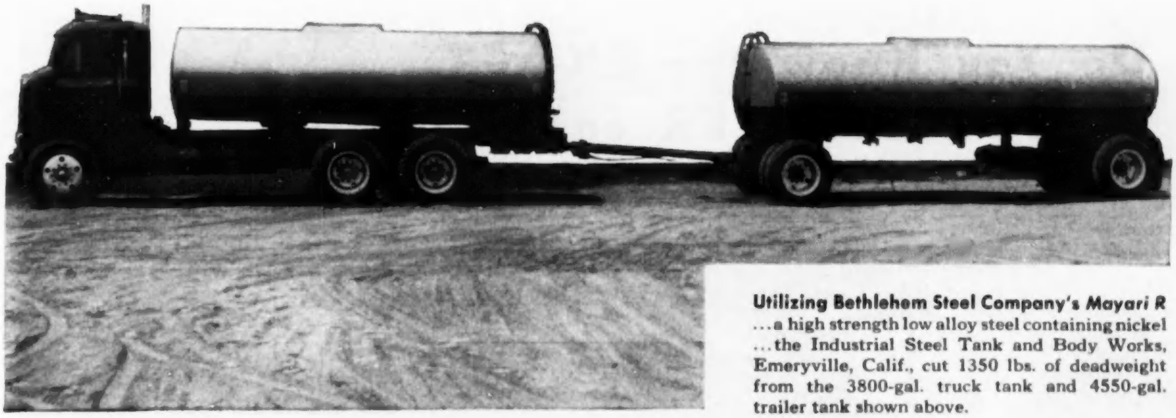
**Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**


Bundy-fabricated fuel line of leakproof Bundyweld Tubing, ready for installation on powerful diesel engine.









**Utilizing Bethlehem Steel Company's *Mayari R*** ...a high strength low alloy steel containing nickel ...the Industrial Steel Tank and Body Works, Emeryville, Calif., cut 1350 lbs. of deadweight from the 3800-gal. truck tank and 4550-gal. trailer tank shown above.

# *Cuts 1350 lbs. of Deadweight*

## from Truck and Trailer Tanks by using High Strength Low Alloy Steel containing Nickel

Contributing the same strength as thicker, heavier sections of plain carbon steel, light sections of high strength low alloy steel containing nickel allow substantial weight reductions in these vehicles...

Obviously, every pound trimmed off not only saves fuel, but reduces wear on tires and brakes. Thus, operating expenses go down. But more important... revenue goes up as a result of increased payloads.

Resistance to many types of corrosion, another valuable property of high strength low alloy steel sheets containing nickel, helps to lengthen the life of vehicle bodies.

These high strength steels containing nickel along with other alloying elements are produced under various trade names by leading steel companies. They provide three basic advantages:

1. High strength in the as-rolled condition, permitting important weight reductions or improved factors of safety.

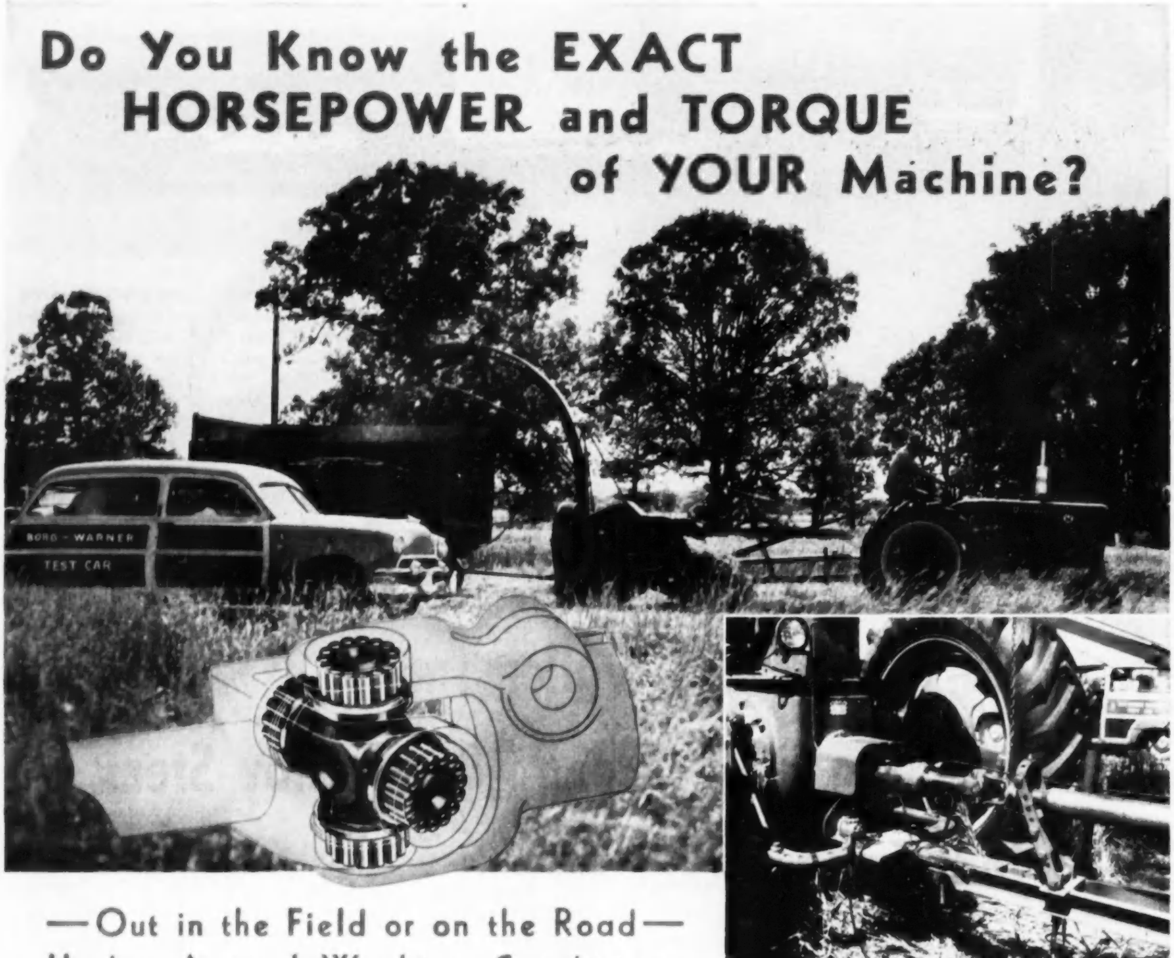
2. Good resistance to corrosion, abrasion and impact.

3. Excellent response to usual fabricating operations, including forming and welding.

Consult us on the use of these high strength nickel alloy steels in your products or equipment. Write today.

**THE INTERNATIONAL NICKEL COMPANY, INC.** 67 WALL STREET NEW YORK 5, N.Y.

# Do You Know the EXACT HORSEPOWER and TORQUE of YOUR Machine?




## —Out in the Field or on the Road— Under Actual Working Conditions

The apparatus in the Borg-Warner test car makes continuous torque readings and shaft speed recordings from minimum operating speeds and loads up to maximum speeds, peak horsepower requirements and stall loads. This mobile test equipment has made numerous, highly accurate operation recordings of cars, trucks, tractors, farm machines, clutch units and industrial machinery. MECHANICS engineers utilize these Borg-Warner tests to insure adequate strength and stamina in MECHANICS Roller Bearing UNIVERSAL JOINT applications. Let them recommend the right joints for *your* machine's torque and horsepower.

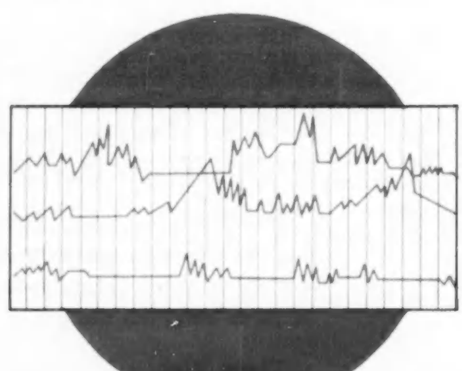
**MECHANICS UNIVERSAL JOINT DIVISION**

**Borg-Warner • 2022 Harrison Avenue, Rockford, Illinois**

**MECHANICS**
*Roller Bearing* BW
**UNIVERSAL JOINTS**

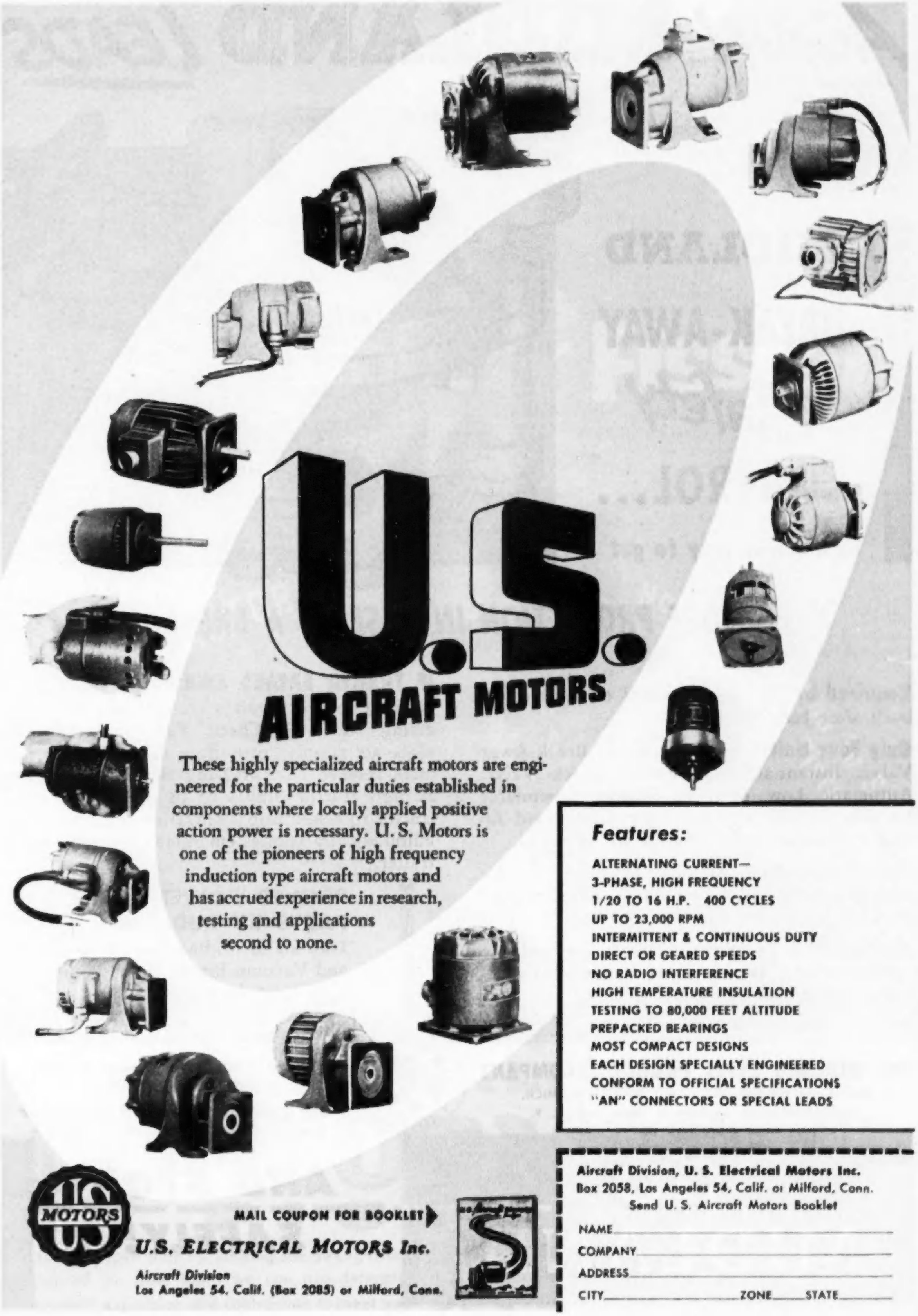
For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

Special attachments to test torque peaks and shaft speeds are located on the machine being tested. The readings are conveyed by wire to the several test units in the car — where accurate recordings are made and computed.



Continuous torque readings and shaft speeds are recorded on tape by the oscillograph unit to provide a permanent, accurate record of the machine's operating characterisitcs from which life expectancy can be computed.


LE ROI


U.S.
AIRCRAFT MOTORS
These highly specialized aircraft motors are engineered for the particular duties established in components where locally applied positive action power is necessary. U. S. Motors is one of the pioneers of high frequency induction type aircraft motors and has accrued experience in research, testing and applications second to none.
Features:
ALTERNATING CURRENT—
3-PHASE, HIGH FREQUENCY
1/20 TO 16 H.P. 400 CYCLES
UP TO 23,000 RPM
INTERMITTENT & CONTINUOUS DUTY
DIRECT OR GEARED SPEEDS
NO RADIO INTERFERENCE
HIGH TEMPERATURE INSULATION
TESTING TO 80,000 FEET ALTITUDE
PREPACKED BEARINGS
MOST COMPACT DESIGNS
EACH DESIGN SPECIALLY ENGINEERED
CONFORM TO OFFICIAL SPECIFICATIONS
"AN" CONNECTORS OR SPECIAL LEADS
US MOTORS US
MAIL COUPON FOR BOOKLET
U.S. ELECTRICAL MOTORS Inc.
Aircraft Division
Los Angeles 54, Calif. (Box 2085) or Milford, Conn.
Aircraft Division, U. S. Electrical Motors Inc.
Box 2058, Los Angeles 54, Calif. or Milford, Conn.
Send U. S. Aircraft Motors Booklet
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COMPANY
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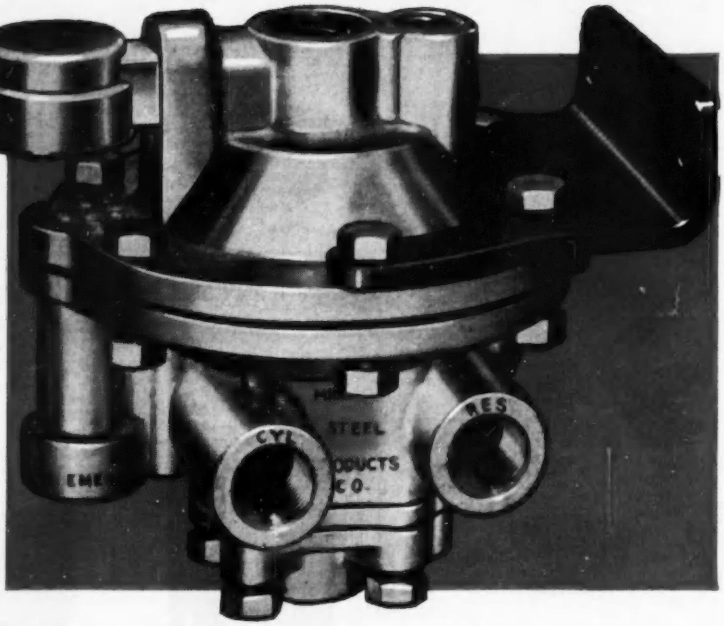
# AGAIN MIDLAND LEADS

## MIDLAND BREAK-AWAY *Safety* CONTROL...

*simplest way to get*



## SAFE, SURE PROTECTION IN CASE OF A BREAK-AWAY!

**Required by I C C**— Required on all tractors built after June 30, 1953.

**Only Four Units**—Fully-automatic Break-Away Valve, Instant-acting Reservoir Check Valve, Automatic Low Pressure Switch, dependable warning Buzzer and attaching tubing and fittings. *All thoroughly proved in service.*

**Fully Automatic**— Break-away system is fully automatic and brake function is fully restored after vehicles have been reconnected.

**Nothing New To Learn**— Driver has only to apply service brakes in usual manner. *No additional controls to operate.*

*Available in Complete Kits.*

**THE MIDLAND STEEL PRODUCTS COMPANY**
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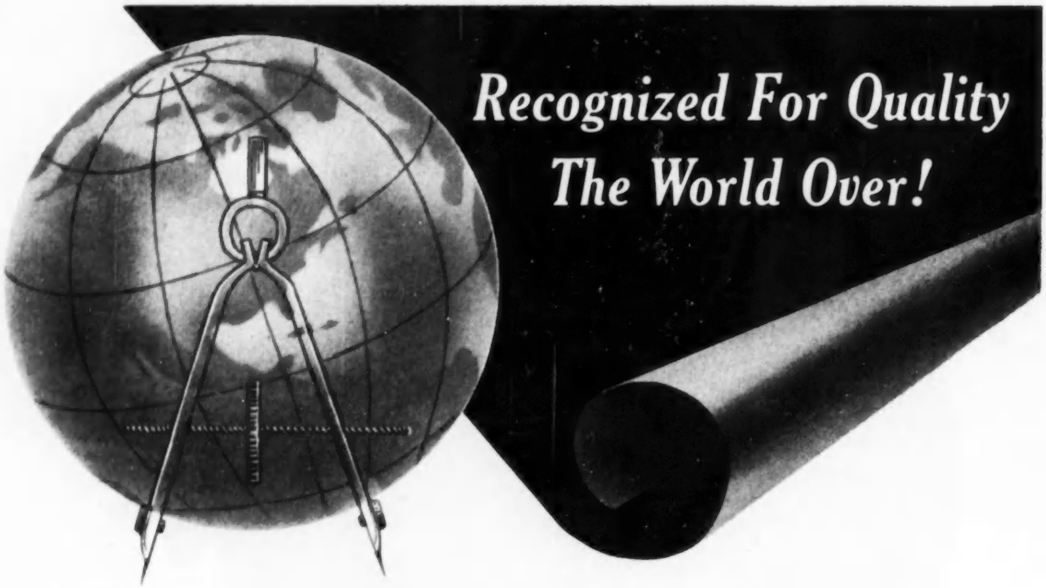


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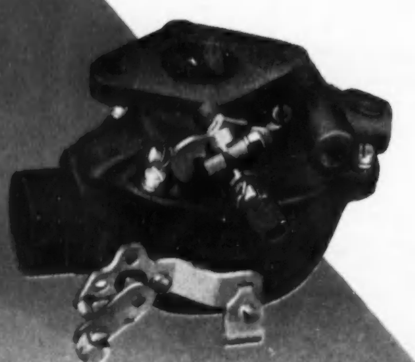

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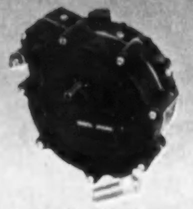

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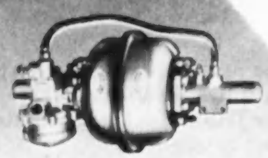

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The design of B-66B is another example of Douglas leadership. Planes that can be produced in quantity to fly *faster and farther with a bigger payload* are a basic concept at Douglas.


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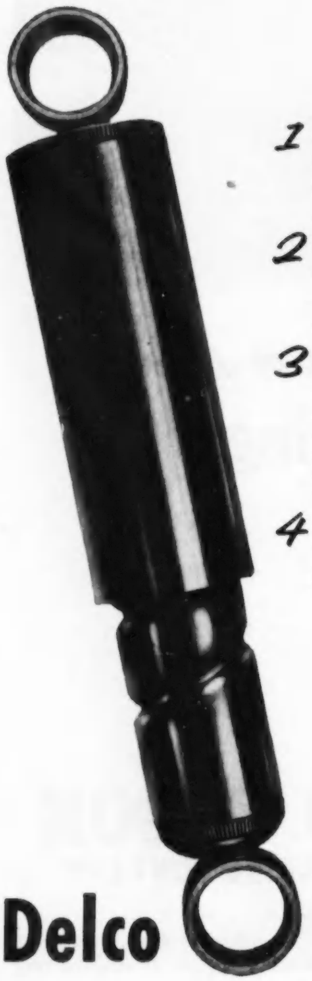

*1* ***Individually Engineered****—Only Delco offers a complete line of shock absorbers in types, sizes and capacities needed for each application.*

*2* ***Uniform Ride****—Exclusive spiral reservoir tube improves performance and maintains uniform control under extreme operating conditions.*

*3* ***Riding Comfort****—Two major design developments permit Delco shock absorbers to give the best in riding comfort—Delco's self-cleaning duplex compression valves . . . and Delco double control pistons.*

*4* ***"Sealed for Life"*** *Construction—Completely welded sealed-in unit for long life and increased safety.*

*5* ***Durability****—Exclusive Delco "Multi-Lip" seal is actually four seals in one—four times better—prevents fluid loss.*

*6* ***Faster Response****—Delco's short orifices permit quicker response to road conditions.*

*7* ***Highest Quality****—Precision construction throughout minimizes wear and increases life.*

*8* ***Strict Conformance to Specifications*** *—Delco shock absorbers are inspected 100% for ride control characteristics.*

**Delco leads the field in production facilities, engineering development and product performance. That is why Delco is original equipment on more new cars and trucks than any other make. Cars equipped with Delco shocks give a better ride on *all* types of roads. Delco Products, Division of General Motors Corporation, Dayton, Ohio.**

# Delco Hydraulic Shock Absorbers

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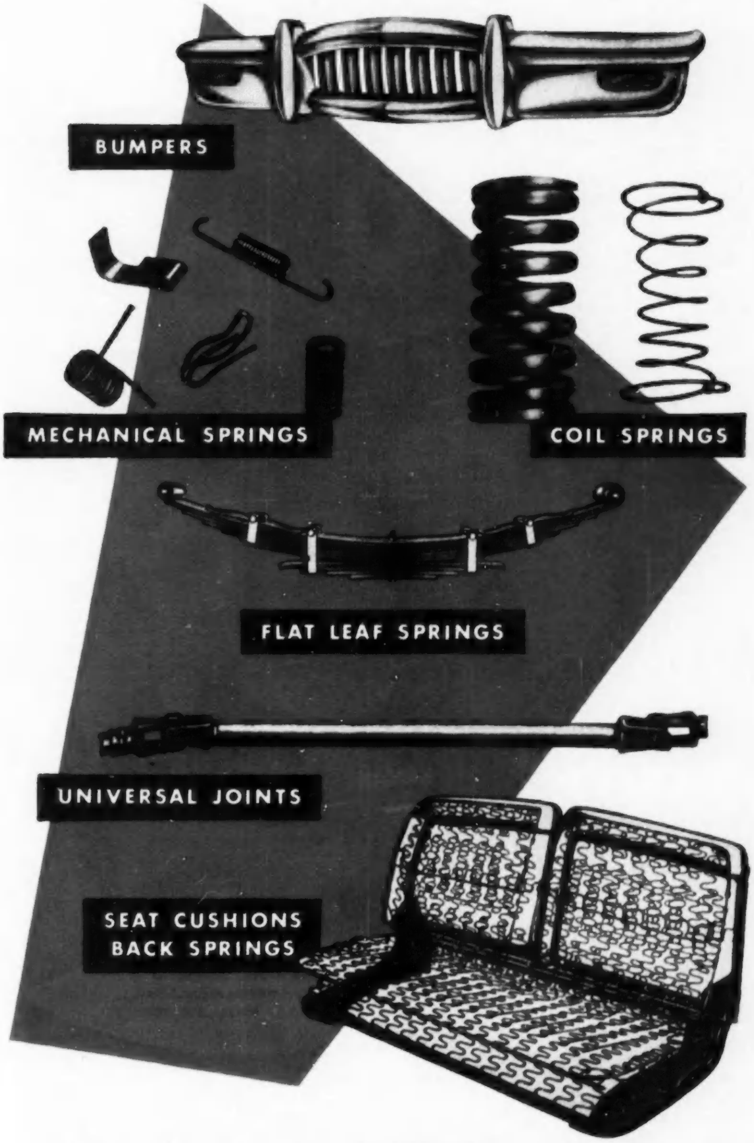


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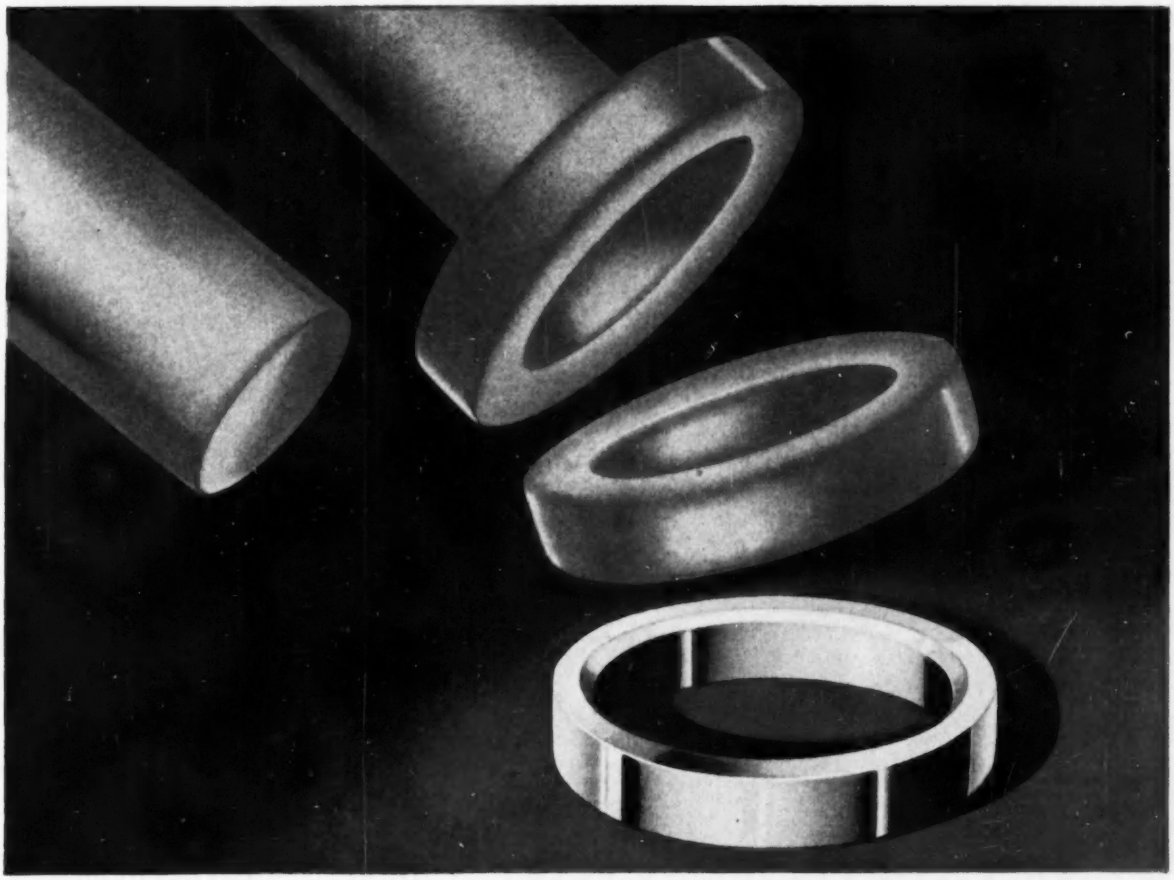

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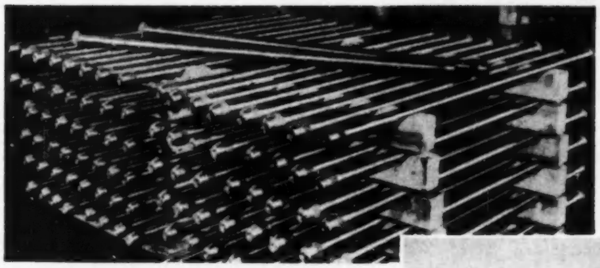
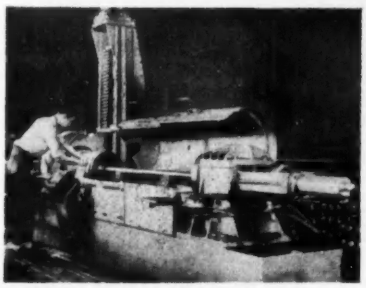
# cushions bone-rattling jolts



## on the world's finest medium tank

**Here are the** Carilloy steel torsion bars ready for shipment. Torsion bars are used on the Patton 48, and others, so that the tanks can be built closer to the ground, giving a lower silhouette.



**On this twister** at the Cicero plant of Maremont Automotive Products, Inc., the finished Carilloy steel torsion bars are prestressed before shipment to the tank manufacturer.

THE army's amazing new Patton 48 not only moves faster, shoots straighter, and offers better protection to the tank crew, than World War II models, but it has a vastly improved suspension system that features torsion bar springs made of U·S·S CARILLOY steel. As a result, it rides lower, more level, and with less jarring.

During rugged field tests, this 45-50-ton tank rolls along at more than 30 miles an hour, knocks down telephone poles and houses, rumbles over deep trenches and scales 3-foot walls. All the while, the CARILLOY steel torsion bars that support the driving wheels flex, twist, and vibrate. They smoothly absorb most of the jolts.

Torsion bars withstand this heavy pounding . . . and do a better job of cushioning these shocks than previous spring systems. What's more they take less space, so the tank can be built closer to the ground and has a lower silhouette.

U·S·S CARILLOY 8660 is a Ni-Cr-Mo electric furnace steel which possesses the hardenability needed in these torsion bars. It will produce a minimum hardness of 55 Rockwell "C" at $\frac{9}{16}$" from the quenched end in the standard End Quench hardenability test. It has exceptionally good surface and sub-surface qualities.

Both the U. S. Army Ordnance Corps and the spring manufacturer, Maremont Automotive Products, Inc., are well satisfied with this excellent performance.

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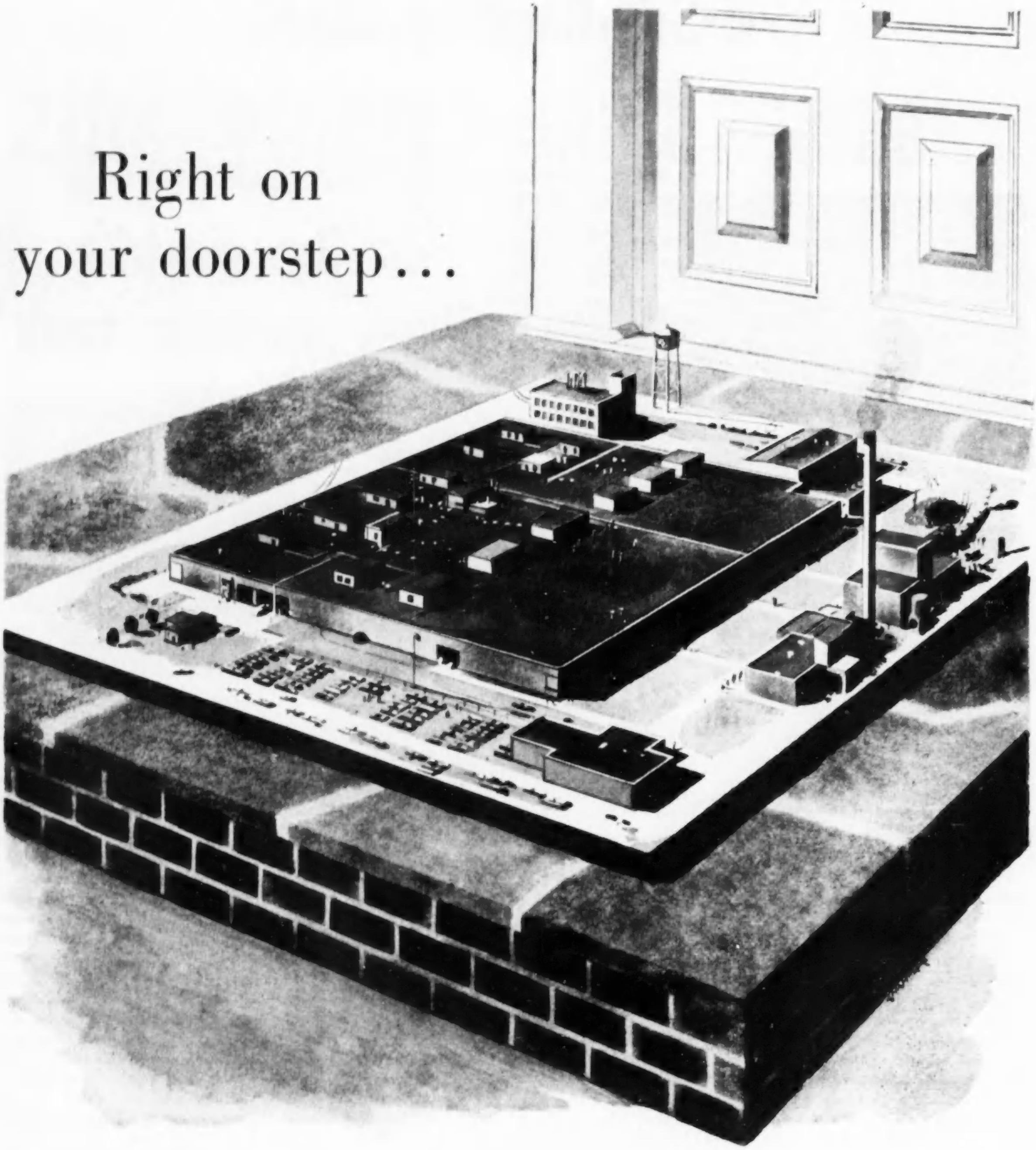


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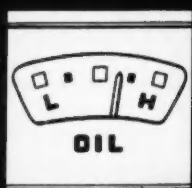


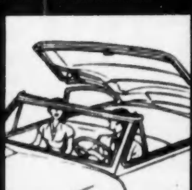

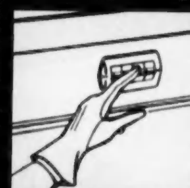

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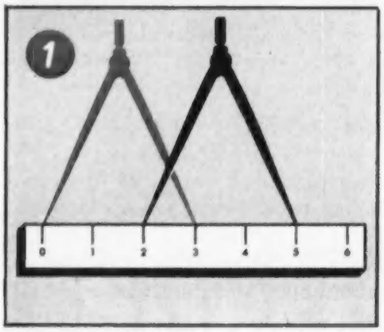
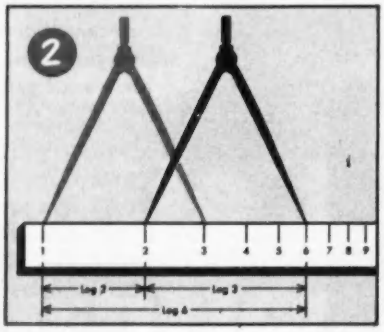
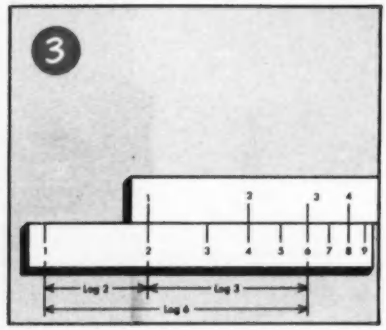
# Why a Slide Rule Adds



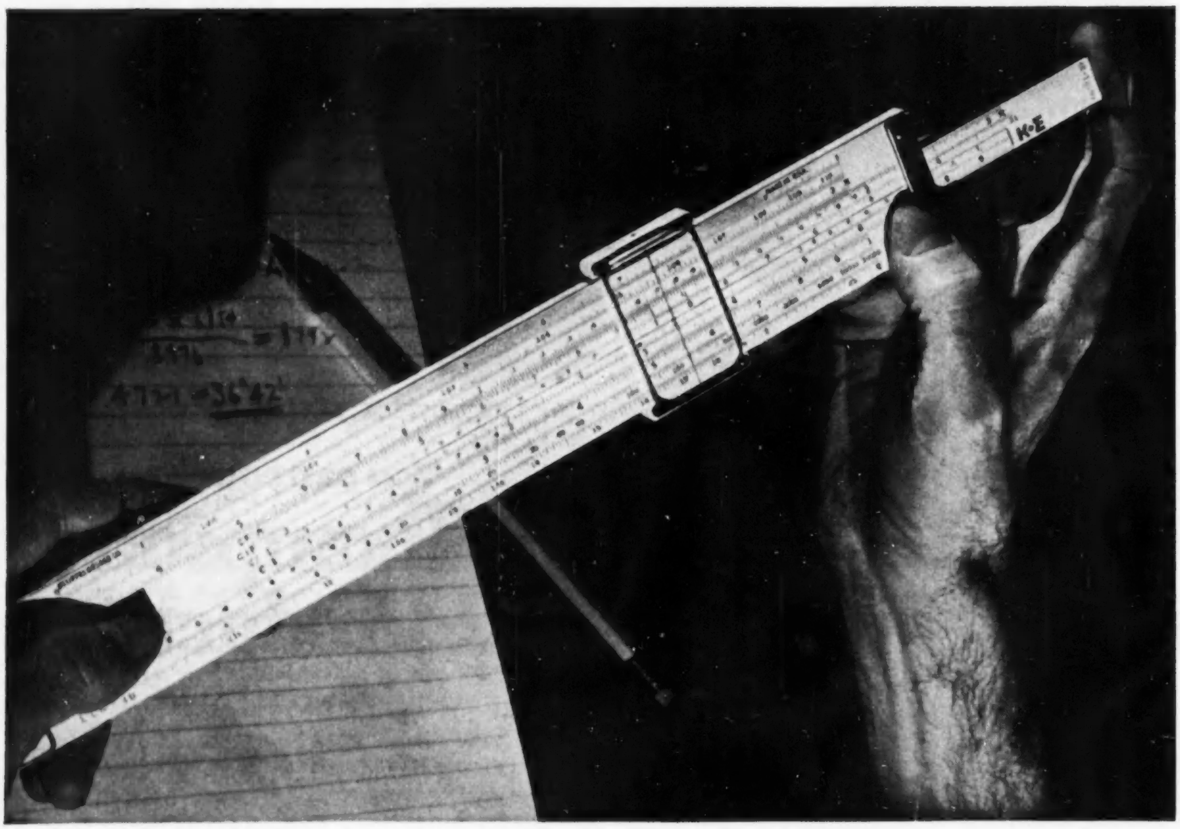



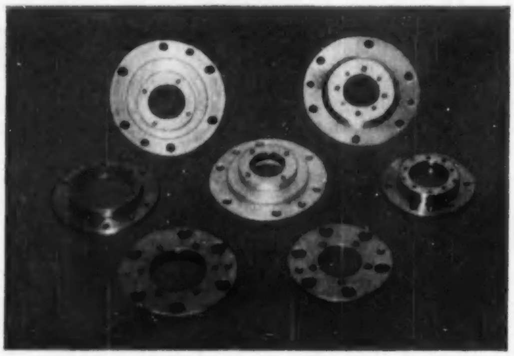




In a mechanical sense, the slide rule merely adds and subtracts quantities. How these simple operations can be performed mechanically may be seen from the illustration above, which shows the addition of 2 and 3 by means of a pair of dividers applied to an ordinary 6-inch rule. Even many electronic calculators work basically on this principle.

With a different system of calibrations on the scale, if appropriate meanings are assigned to them, more difficult problems may be solved in the same way. An example of this is seen above where a pair of dividers is shown adding 2 and 3 on a logarithmic scale and obtaining the answer 6. Advantage is taken of the fact that the multiplication of numbers may be accomplished by the addition of their logarithms.

A handier method, which begins to approach the usefulness of a slide rule, is to place two similar logarithmic scales together. Seen above is the simple setting in which 2 is shown being multiplied by 3. Observing the illustration it can be seen that the same setting also multiplies 2 by 2 and 4. Without changing the setting, the device shows the corresponding operations in division.










INCHES OF WATER

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